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THE KRUPP MONUMENT IN ESSEN.

THE city of Essen has erected, and unveiled on July 14, a statue of her world-renowned son Alfred Krupp, who died about two years ago. The Berlin sculptor, Schaper, was chosen from a number of competitors to carry out the work, the decision of the judges being influenced by his statues of Bismarck and Moltke. This new work of his stands on a plain granite pedestal in the market place between the Evangelical church and the Rathhaus.

The artist fulfilled the task set him in the most thoroughly realistic manner, bringing out the characteristics of the man. He has shown perfectly the bearing and expression of the leader who climbed steadily from small beginnings by caution, perseverance, and energy, until he became the master of an establishment which was the only one of its kind, its 15,000 workmen and other employes forming a community by themselves. The artist has represented him as standing with his right hand on an anvil and his left, which holds his crushed cap, resting on his hip. He is clothed in a comfortable jacket and high boots, just as he was seen daily at his works. The statue gives a good idea of his character, as well as of the external man, and in looking at the erect, sinewy form and quiet face, one feels clearly that only a life rich in works and with a real, well-defined aim could stamp that resolute and thoughtful expression on the mouth and eyes.

Schaper's statue of Krupp, which will always be a true and lifelike portrait of Essen's most noted citizen, is a new proof that the modern realist can give a correct representation of life in plaster. It is proposed to erect a second statue of Krupp directly on the ground where he worked.
—*Illustrirte Zeitung.*

THE STATUE OF ALFRED KRUPP, AT ESSEN.

COGNAC AND ITS WORKING CLASSES.

REPORT OF CONSUL EARLE.

THE TOWN OF COGNAC.

THE town of Cognac is one of the most ancient in this section of France, its history stretching back through the Middle Ages to the Roman invasion of Gaul. The present town, however, may be dated from the time of Francis I., of Catherine de Medici, and the religious wars. At these epochs Cognac was a place of considerable importance, first from the affection Francis always bore it (his birthplace), the frequency of his visits here with his court, and the privileges and immunities he conferred on the town; and later by the importance attached to it from a strategic point of view by the Admiral de Coligny, the Prince de Conde, the Count de Harcourt, and others, and was the scene of many battles and sieges between those captains. I mention these historic facts to give some idea of the physical appearance of the town, the plat and plan of which, I take it, are much as Francis I. and Charles IX. left it.

It is nearly circular in form, of a radius of about 1 kilometer (kilometer=0·621376 of a mile), and is divided into two unequal parts by the Charente River. The bulk of the town, say two-thirds, lies on the left bank of the stream; that on the right bank is called the Faubourg St. Jacques. The Charente is navigable as high as Angouleme to small schooners and luggers, but as high as Cognac to vessels of that class of from 100 to 150 tons burden. It is estimated that two-thirds of the brandy made here is shipped to the sea coast by the Charente River. There is an excellent quay extending from Pont Neuf (a beautiful stone bridge which connects the town and the faubourg) about 400 meters down the stream. The town and the faubourg both slope gently down to the river, thus insuring over its paved streets perfect surface drainage.

The streets, as a rule, are very narrow and inexpressibly crooked. The principal ones are paved with Belgian blocks, laid on a deep foundation of concrete or macadam. Others are simply macadamized with the soft native cretaceous stone. The sidewalks are also very narrow, paved with granite or hard artificial stone, and curbed and guttered, as a rule, with granite. There is an extensive park, extending more than a kilometer up the river from Pont Neuf, and many smaller open spaces scattered through the town, where the inhabitants can get fresh air in summer. Among the latter are Place François I., Place de la Corderie, Place Beaulieu, Place de la Salle Verte, Place de la Sousprefecture. All these places, except that of François I., are planted out with trees and supplied with benches. In the summer these open spaces are frequented by rich and poor alike, and in all seasons, when the weather permits, they are used by the children as playgrounds.

The town is supplied with water from the River La Douce Charente (the sweet Charente, it is called), and above and below the pump house for certain given distances the stream is rigidly policed to see that the water is not polluted. The supply of water is abundant for all domestic and sanitary purposes, and is apparently quite pure. There are many public plugs or hydrants where the poor, who have no water connections in their houses, can supply themselves.

HOUSES AND HOUSE RENTS.

The geological formation is a soft, white cretaceous stone, which seems to underlie the whole country at quite a shallow depth. This stone is easily quarried and the quarried stone easily dressed. The latter operation is usually done by a single workman, who saws the blocks into such sizes and shapes as he chooses with an ordinary cross-cut saw, and afterward smooths off the blocks with a plane like a jack plane.

From the abundance and cheapness of this stone it forms almost the only building material used in the construction of the walls of houses. Where brick is employed at all, it is generally only as an outer coating, or veneer, on the front wall, the rest being of rubble stone. Hence I may say that almost all the houses are built of stone, the better ones faced and trimmed with sawn stone and the commoner ones of rubble stuccoed, and all are roofed with red corrugated, earthen tiles. My observation is that for this climate the houses are, as a rule, comfortable, and the rents demanded for them are not high. An ordinary family of working people would require, for example, a kitchen, two bed rooms, a share of a cellar, and a share of an attic. These accommodations would cost them from 200 to 250 francs a year.

THE BRANDY INDUSTRY.

The brandy trade is the principal if not the sole industry of Cognac. This includes the distillation of the celebrated brandies, the blending of them and their preparation for market or export. Around these industries, of course, are clustered others, as hoop and stave making, cooper shops, case making, glass blowing, lithographing labels, etc., not to speak of others directly concerned in the production and manipulation of the brandy. In former years, before the ravages of the phylloxera on the vines of La Charente began to be so severely felt, the great plain lying southeast of Cognac, an ellipse of about 15 by 25 kilometers, was one vast vineyard. Here was produced the grand fine champagne

which gave to the brandies of this part of France the pre-eminent name of cognac. These vines have disappeared, however, almost to a root, and all those who formerly made good livings by tilling and pruning the vine and gathering the rich harvest find their vocation gone.

It was formerly the custom—and still is when any one is lucky enough to have a vineyard which the phylloxera has spared—for each small proprietor to make his own wine and to distill from it his own brandy. These brandies—new or old, according to the ability of the producer to hold them to age—are sold to the great export houses, whose names we see on the labels of the bottles of cognac in American restaurants. By these latter the brandies are simply blended. As a matter of fact, I believe but little brandy is distilled by the houses best known in America in connection with cognac. Of its adulteration, and whence is derived the materials for its legitimate production, I have nothing to say in this place. My predecessor, Mr. Malmros, has already treated ably of that subject in his report on cognac brandy to the department, December 16, 1888. It is enough for my purpose to say here that the vines of the grand champagne, or, in other words, the environs of Cognac, are dead, and those who were formerly profitably employed in the culture of the vine and the manipulation of its products are either not employed or are inadequately so. To the former class belong the old people, the women and children, all of whom could make themselves useful during the harvest, etc.; to the latter adult men, trained to that work, and, so far as it is concerned, skilled laborers. These latter are now degenerated into common hands in consequence of want of work in the fields. Both these classes have come in great numbers from their hamlets to Cognac to try to earn a living, or get one somehow, in town. As is to be expected from such an influx of unskilled labor, the price of that commodity has gone down. Many have not succeeded, in getting any work, and great poverty and beggary are frequent.

A custom prevails here among those who can afford it of distribution of alms to the poor on the day of the interment of a member of the family. These alms may take the form of a loaf of bread or a sum of money, varying from a few sous to several francs, to each poor person who applies. Several days ago the remains of Mr. Martell, a member of the great house of Martell & Co., were brought here for burial, and, notwithstanding the cold, drenching rain, the streets were thronged with the poor in all stages of poverty—from seedy middle-aged men and women and old crones, bent double with age and clothed in rags, to young, wretched-looking females carrying and leading half a dozen miserable children. The last I discovered, however, was a dodge. The aumone was distributed during three days, and when a single poor person presented him or herself, they got a certain small sum of money. When, however, they were accompanied by children, they got larger alms. Hence, the babies and ragged urchins of a quarter were pooled and carried and led in squads by different women, at different hours, and on different days. One of Mr. Martell's employes told me that there were over two thousand who applied the first day, and on the two following days I did not observe much diminution in the throng of miserable-looking folk on the street. Of course, the major part of these were "repeaters." But this episode will give some idea of the amount of poverty there is here.

WAGES.

The average wages which workingmen get in Cognac may be stated to be from 48 to 58 cents a day. Of course, skilled laborers, as distillers, blenders, master coopers, etc., get more, but, as a general rule, when I ask an employer how much he pays his men, he gives me the above figures. Girls and women in service get from $1.93 to $3.86 a month, board and lodging. For this they do the family work. Charwomen working by the day, sewing women, etc., get 40 cents when they board themselves, and 28 cents where their breakfast, eaten at noon, is furnished them.

These prices, one would say, are not so extremely low if the necessaries of life are cheap in proportion. Such, however, is not the case here. What we call in the United States the necessaries of life are not by any means cheap, and many articles classed by us under that head are much dearer here than at home. All articles of clothing, except cotton goods, are cheaper here than in the United states. Shoes and hats don't count for much, as the poor universally wear wooden shoes and home-knit caps.

FOOD.

Bread here is literally the staff of life and the principal article of food. One sees every day people on the street carrying on their heads and under their arms great loaves of coarse, dark-colored bread weighing from 6 pounds up; some of the loaves look big enough to weigh 25 pounds. My charwoman—who boards herself—tells me that she, her husband, and their little boy, a lad of ten, eat a 6 pound loaf of bread a day. They have also some cheese, and for drink a something they call piquette. It is made by soaking fresh or dried grapes in water, adding a little brown sugar, and letting it ferment. They also make it of bruised apples and the cores and parings of apples used for other purposes. They have coffee sometimes, meat rarely, and even then the cheaper parts. Vegetables in the summer are abundant and cheap, and form an important part of the bill of fare. Roasted chestnuts are also much employed as an article of food. They are extremely economical, wasting nothing, and making everything go as far as it can.

Thus the people live, and I suppose there are few who know any other order of existence who much envy them their lot. It has not always been so here, however. Before the destruction of the vineyards this was one of the most prosperous parts of France. Even now much is hoped for from the investigations of the committee of viticulture, and many vines are now being planted out, some on native and some on American roots. The result remains to be seen.

CANADA doesn't produce enough pork in a year, the Ottawa *Free Press* says, to supply one ordinary gang of lumbermen, and thousands of barrels are annually imported from Chicago for the lumbermen, which accounts for the fact that the Canadians have decided not to raise the duty on mess pork.

ON THE OBSERVATION OF SUDDEN PHENOMENA.*

S. P. LANGLEY.

BY a sudden phenomenon is here meant one of that large class where the occurrence is awaited without the observer's previous knowledge of its exact instant, and of which familiar examples may be found in the bursting of a rocket, the appearance of a meteor, or the emergence of a star from behind the moon. A great part of all the phenomena of daily life, as well as of scientific observation, are of this kind, though the importance of a special instance of another class (I refer to the gradual and foreseen approach of a star to a wire) has drawn to this latter such particular attention that we are apt to think only of it when "personal error" is in question.

When, in an observatory, we study the means taken to record the precise time of the transit of a star, we find that the precision of modern apparatus has reduced the error which we may expect in almost any part of the mechanism to an extremely minute amount which may be calculated to the fractional part of the one hundredth of a second. I say "almost," for, as we are all aware, there is one notable exception, at least until photography can be made to intervene. The human brain and nerves, and behind these the inscrutable processes of the will, themselves form an inevitable link in the chain of apparatus of observation, and here an error may and does arise enormously greater than that of all the rest put together.

We all know that this error varies with the individual and the occasion. It is most constant in the experienced observer, but even in his case it varies with the daily accidents of the human organism, and even with him it is presumably constant only for the particular observation to which the experience applies. There is not even a presumption, I think, that the personal equation belonging to an experienced transit observer would apply to the same person's notation of the occultation or emergence of a star, and still less, if possible,

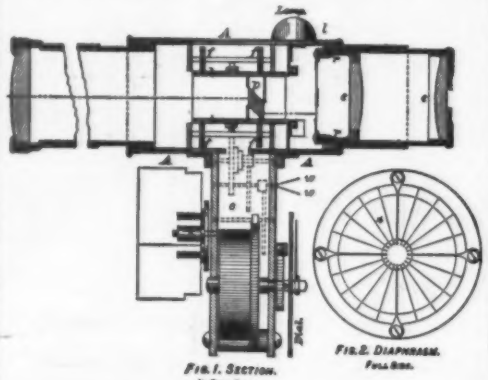

FIG. 1. SECTION. FIG. 2. DIAPHRAGM.

S. P. LANGLEY. INVT

to any phenomenon outside his ordinary professional experience; for we must, of course, recognize that we carry this fallibility with us in every act of life, and that it is just as present when we attempt to determine the instant at which a race horse passes the winning post as when we seek to note the particular hundredth of a second at which a star passes the wire.

The very words "personal equation" imply that the errors due to this fallibility can be ascertained and allowed for, and may lead us to think (if we think carelessly) that there is a personal equation always ascertainable; whereas, as we in fact know, it is only possible to apply the correction where long habit has settled the amount of error to be expected with regard to some one special phenomenon.

The number of devices for obtaining and correcting the personal equation, even in the special case of meridian observation, is, as those who have studied the subject know, surprisingly great. I think I have myself examined more than fifty such, and with hardly an exception they all exhibit variations on one idea—the idea, that is, that the error must have been committed *first;* the committing of the error being assumed to be an inevitable necessity, for which subsequent correction has to be made.

I have thought, then, that it might be interesting if I were to ask you to consider with me what may seem at first the somewhat paradoxical suggestion, that means may be found by which any individual, skilled or ignorant, may make, not only meridian observations, but an observation of any sudden visible event of whatever nature so accurately that we need apply no correction, because the precision may be, if not absolute, at least such that no correction will in ordinary practice be needed. I may deceive myself in thinking that what I have to suggest involves a novel idea, but I am led to suppose so from the fact that I have met no application of it in a somewhat extended reading on this point.

Let me first remark that while such error as that in question doubtless belongs to all the senses in some degree, we are at this moment considering it in connection with the sense of sight only.

When we see anything in motion (let us suppose for instance a passing train on the railroad), we have the well known fact that—

First. An instantaneous photograph is made by the optic lens upon the retina, there being a picture formed there which is perfectly distinct, but which fades out upon the retinal plate in from one-tenth to one-quarter of a second, while the perception of this image is under ordinary circumstances† sensibly instantaneous; (but)—

Second. Nerves convey the distinct impression of every part of this picture to the brain, and it is here, if we have to act on this impression, that a certain time is lost, not only in the carrying of the message along one set of nerves and the bringing back the answer on the other, but in the decision that is being made by that unknown and inner self which appears to us to exert here a more or less conscious act of will.

In the case of a sudden and startling event, the time elapsed may be almost indefinitely great; and in some cases, probably several entire seconds may pass without the consciousness of the observer. A very imperfectly appreciated interval must occur in all cases, for what we have just said applies to every event of our daily lives, and the professional observation is only a particular instance of it.

Now, I ask your attention to the practical instantaneity of the *formation* of this visual picture, which is known to be obtained where the duration of the phenomenon to be observed is much less than the one thousand-millionth of a second, and where we have every reason to believe that the actual formation of the image on the retina under known ordinary conditions requires a time of like order.

We may say, then, that the casting of a picture on the retina is instantaneous. It is fading out that requires time, and it is while this fading out takes place, and even long after it, that the work of perception, decision, and action is going on behind the retinal curtain in the chambers of the brain. Notice, then, that while to determine *when* a phenomenon occurs may require, under some circumstances, several seconds, and under all ordinary circumstances a notable fraction of a second, to determine *where* it occurs requires (sensibly) no time at all, for one single impression remains on the retina long enough to obtain full recognition and to be produced by processes of memory.

I can make my meaning clearer, perhaps, by using the same specific instance as before. Let us suppose that an accident to a passenger on the passing train is the phenomenon, the time of whose occurrence is to be noted, and that this accident is seen from a room in which there are two windows looking on the track. We must have seen the accident, if it be instantaneous, either through the first window or the second. If we had been led to anticipate that we should be called upon to say through which window we saw it, I think we may all admit that there would be no discrepancy on this point between different observers, for in this case we are considering only the element of position, and the element of time does not directly enter at all, so that observers in the same position who had been bidden to note through which window they saw it would all agree on this point.

Now a connection can here obviously be established between the place and the time, from which we infer the latter, if we are granted the knowledge of two facts; the time at which the carriage could have first come into view from the first window, and the time at which it must have passed out of view behind the second; for if we suppose the speed of the train to have been uniform, we have the means of deciding the fraction of the time when we know the fraction of space. Here, then, as in the case of a common clock or chronograph, or any device where time and space are proportional, we can infer the former from the latter; only let it be observed that we here need no recording apparatus. What we use is the memory of where the event occurred; in other words, we recall the impression on the retinal screen, and have no need to bring into use what we may call the time perception apparatus of the brain which lies behind it; *nor do we in fact need that the object of our observation shall be really in motion, but only that it shall be made to appear to be so.*

This last point is all important, and what I ask your attention to is an experiment heretofore, I think, untried, and which is, perhaps, a novel application of the fundamental horological idea that time and space must be made proportional, for it seems to me that it must be theoretically possible, not only in the case of the clock or the chronograph, but always, to so connect the former with the latter that the essential task of the observer is to say where any visible event apparently occurred, and then let some mechanism outside of himself say when.

That, at least, is the idea, and if it has, as I hope, been clearly apprehended by you, I will now ask your attention to a working plan for carrying it out. Numerous different devices have been under my consideration. I will take one which is primarily designed for the observation of any celestial phenomenon, though it could very well be adapted to terrestrial ones; and in order to fix our ideas I will suppose that we have an event which we know the approximate time of, but which may burst upon us at some fraction of a second which we want to determine. I will assume (merely to fix our thoughts) that we wish to note the time at which a star emerges from behind the dark body of the moon with an accuracy which insures us that we have not made an error so great as one twentieth of a second.

You see I hold in my hand a peculiar eye-piece, which has been made to observe this or any other terrestrial or celestial phenomenon of sudden occurrence. It can also be used for meridian observation, but its special field seems to lie in noting an event where no correction for personal equation is applicable. This event may be anything celestial or terrestrial, from the entrance of Venus on the disk of the sun to the explosion of a mine; but, for the purpose of illustration merely, let us take it to be the sudden appearance of a star.

On looking into the telescope we see, in the first place, two prominent wires crossing each other at right angles, dividing the field of view into four quadrants. Now, by a simple mechanism, which I shall shortly explain, any object that our telescope is directed on—any fixed star, for example—seems to be revolving in the field, passing successively through the first, second, third, and fourth quadrants. If the star is hidden the mechanism is working just the same, and when the star appears it must evidently first be seen in some particular one of those four quadrants, and experience shows that we shall have no difficulty in telling in which one. The mechanism itself has recorded for us by an electric contact the limiting instant between which it is possible to see the beginning and the end of the cycle during which revolution may be supposed to be made. It is not necessary that this cycle should last just one second; but, supposing it (still for illustration only) to be a second, if it was seen in the first quadrant, it was seen in the first quarter of the second; if it was in the second quadrant, some time in the second quarter of the second; in the third, in the third quarter; in the fourth, in the final quarter. All that we have to do in this case is to know in which second it

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* Read before the Philosophical Society, Washington, D. C., March 2, 1889.

† The writer's observations (*Am. Jour. Sc.*, Nov., 1888) show that appreciable time is required for perception of the retinal impression, with certain excessively faint lights; but these are not here in question.

occurred; for the quarter of a second we may say is noted for us by the purely automatic action of the optic lens and retina, since the first image on the retina must be that of the star as seen in some particular one of the four quadrants.

Going a little further, we will now suppose each of the four quadrants, which in turn correspond to quarter seconds, to be divided into five parts, so that the whole circle is divided into twenty. All the observer has to say is in which quadrant and in which subdivision of the quadrant the star appears, to say in which twentieth of the second (or other brief cycle) it emerged.

The reticule I have just described is fixed in the focus of the eye-piece and does not revolve. What does revolve is a minute double prism of total reflection just before the reticule, the middle of whose reflecting face lies in the optical axis, and by whose means the optical axis is twice broken at a right angle, so that when the telescope is directed at a star, the image of the star is not seen at the center of the field, but on one side of it. If the prism is revolved, the star must appear to revolve in a circle whose radius is nearly that of the side of the prism.

The little prism is turned by a small piece of watch-work, but it is not at all necessary that this should be exact, since all we demand is that the rate shall be constant during a second or so—a condition easily secured with the most ordinary mechanism.

The sketch and the apparatus exhibited sufficiently indicate, I think, the simple means by which this is brought about.

Fig. 1 is a section one-half full size. A A A is the outer tube, which can be fitted, if desired, into the eye end of a telescope. *b b* is the inner tube, resting on friction wheels, *f f*, revolved by the clockwork, *c*, about once a second, and recording the time at which a key in the observer's hand may be pressed to indicate the particular second. This record may be made electrically by the wires, *w w*, on a chronograph, or more simply and directly on a little attached dial like that of a recording stop watch.

p is the prism of double total reflection. *r r* is the position of the fixed reticule (shown independently as it appears to the observer and of full size in Fig. 2).

e e are the lenses of a positive eye-piece. *l* is a lamp for giving wire illumination, if desired, when a telescope is employed.

Field illumination is readily obtained by making the diaphragm in which the prism, *p*, is set, of translucent material.

Finally, it should be remarked that on removing the eye-piece, events may be observed without using any telescope. In this, its simplest form, the chronograph may also be dispensed with, and the record of the second made on an attached stop watch dial, and the instrument may thus carry its own complete recording apparatus and be more portable than an ordinary opera glass.

I have not found time to use this apparatus on the moon or occultations, but I have, what is possibly more to the purpose now, tried it on an artificial star, the instant of whose appearance and disappearance was independently recorded on a chronograph by an electrical contact. Different observers, entirely unskilled and ignorant in the use of the instrument, were invited to look into it and to determine the quadrant and section in which the star appeared and disappeared.

I have momentarily mislaid my notes containing in full detail the results of four observers, but I can summarize them approximately in saying that after being simply told what to note, the average probable error (that is, for any single observation) was rather less than one-twentieth of a second. As far as I can judge from the limited number of instances, the younger the observer the better the observation. The worst of the observers (the oldest), however, had a probable error considerably less than one-tenth of a second; the youngest, a probable error of something like one fortieth of a second which implies, as you will observe, that he not only readily noted the quadrant and the subdivisions of the quadrant, but also, as a rule, even the part of subdivision in which the star was first seen. None of these had so much as one hour's practice.

The plan in question is easily adapted to meridian observations, but for these we have numerous plans for correcting personal equation, and the writer may also direct attention to the fact of the existence of a distinct device (*American Journal of Science*, July, 1877) which practically eliminates the personal error in the very act of a transit observation. It is more elaborate than the present one, which is so simple that it may be useful even in longitude work with the transit, though its proper field seems to be the observation of sudden events; but, to whatever purpose it is applied, I beg leave to present it to your attention less for any interest that attaches to the particular mechanism exhibited than as an illustration of a principle which seems to me to have not been employed before in this way, and which I trust may have useful applications.

WIRE CABLES.

THE following about a cable that was recently removed from the California street cable road will be of interest:

The diameter of the cable was an inch and a quarter when it was laid, but twenty months of constant hauling and wear thinned it down nearly an eighth of an inch.

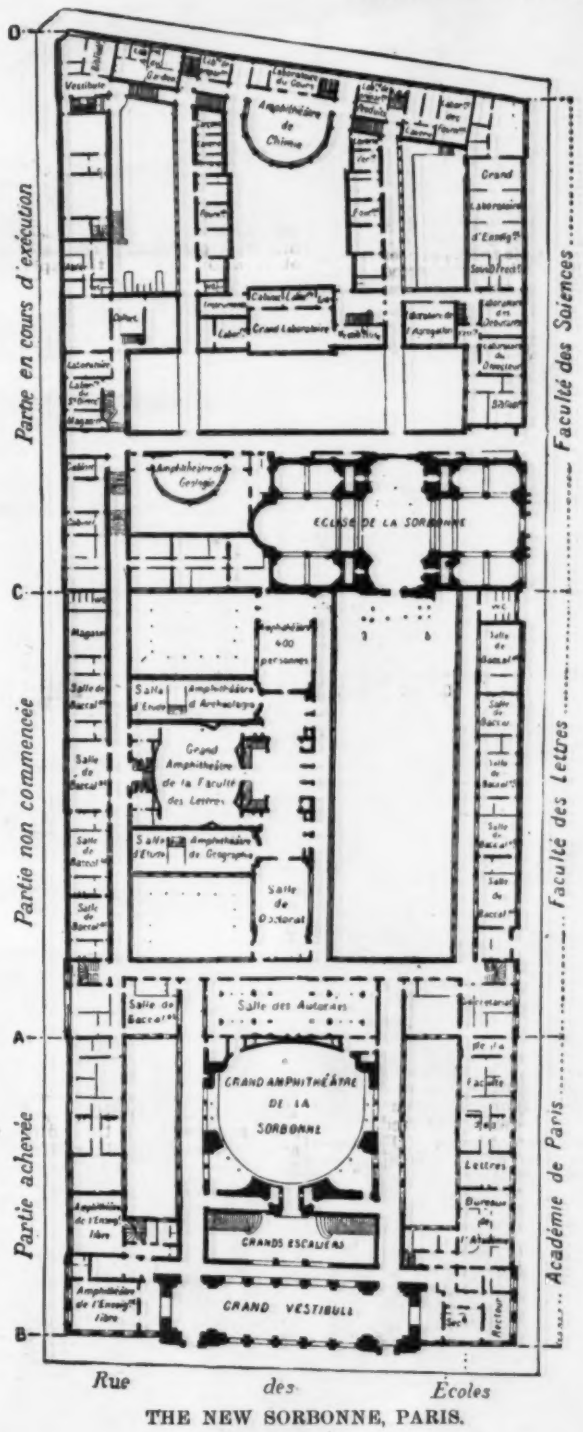
Its length was 17,513 feet and its weight 44,604 pounds. For nineteen hours a day it kept moving every day of the twenty months, and as its speed was seven miles an hour, the distance it traveled was 79,800 miles. It carried nearly 6,000,000 people, or about six times the population of the State, and turned over to the company $300,000 worth of nickels, being at the rate of $15,000 a month or $500 a day. As the total power of the road is 400 horse power, it may be calculated this rope was doing as much hauling while in motion as 200 horses, and as each car hauled by horses uses four teams a day, the daily work of this cable was equal to that of 800 horses, with a deduction, however, for the great power required to move 44,604 pounds of cable.

The cable was composed of six strands of steel wire cables, each one containing nineteen wires varying in size from six to eight wire gauge, and twisted around a stout hempen core, five-eighths of an inch in diameter. —*Pacific Lumberman.*

THE SORBONNE, PARIS.

THE following sketch of the history of the Sorbonne is from Appleton's Cyclopædia.

Sorbonne, the principal school of theology in the ancient University of Paris, was founded in 1253 by Robert de Sorbonne or Sorbon, so called from his birthplace in Champagne. He had been a poor student, but became chaplain to Louis IX. in 1253, and founded with the king's aid a collegiate school for the gratuitous education of poor students in theology. He secured the services of three secular professors, Guillaume de Saint-Amour, Eudes de Douai, and Laurent Langlois, and formed with them, and 16 poor students under his own direction, a community which served as a model for similar collegiate schools in the universities of France and England. The charter granted in 1253 by Louis IX. was confirmed and enlarged by Pope Clement IV. in 1268. Before 1253 theological instruction was given in the bishop's school near the cathedral of Notre Dame; thenceforward it was given exclusively at the Sorbonne.



THE NEW SORBONNE, PARIS.

Robert also founded near the college a preparatory seminary called "the little Sorbonne," which was destroyed in 1685, when the present church of the Sorbonne was erected on its site. He provided a library of 1,000 volumes, which was increased by subsequent benefactors, especially by Cardinal Richelieu. The members of the college (*maison de Sorbonne*) were divided into fellows (*socii*) and commoners (*hospites*). The fellows, composing the faculty, were all secular priests, doctors or bachelors in divinity, selected for their eminent learning, after undergoing the test of a severe public examination, a triple ballot, and teaching a course of mental philosophy. Besides the strict necessaries of life provided in the college, the poorest among them received a trifling stipend.

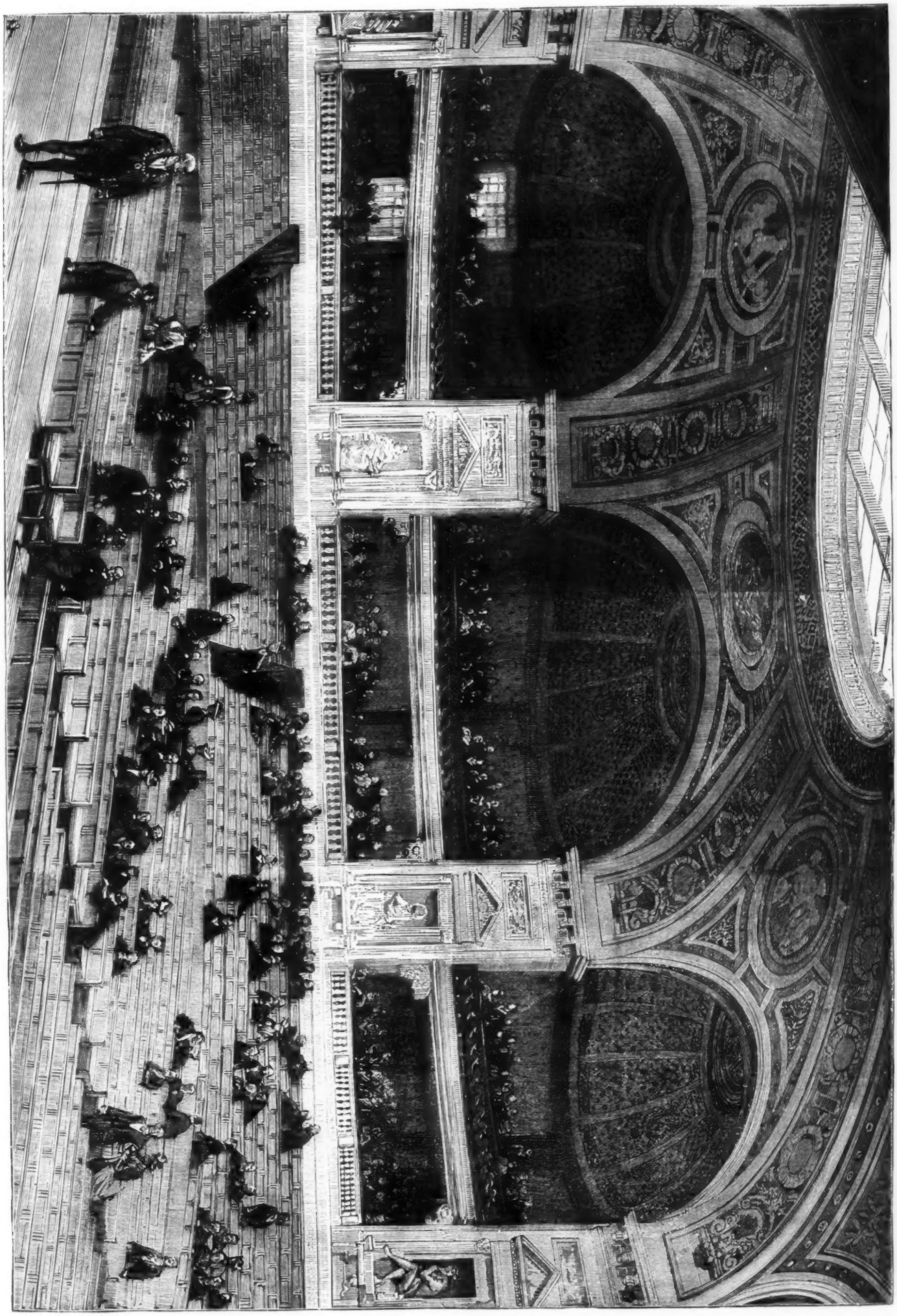
The commoners were required to be bachelors in divinity, were chosen from among the most talented of their class after the most rigorous ordeal, and were maintained by the college, but had no voice in its government. The fellows were nominated for life, and were officially designated "fellows or bachelors of the house and society of the Sorbonne;" the commoners were styled "bachelors of the house of the Sorbonne," and their membership ceased on their graduating as doctors. The college property was vested in the fellows, and all business was managed in their name. A perfect equality reigned among them; the holding of office implied no superiority or power of one over another. No member of a religous order was admitted into their body, and a fellowship was forfeited by entering such an order.

The exceeding rigor exercised in the selection both of fellows and of commoners was for the purpose of maintaining a high standard of intellectual culture among the secular priesthood. But the vast lecture halls attached to the college were open to all poor scholars indiscriminately, and the professors were pledged never to refuse to teach any such, while students who had means were required to pay the usual university fees. From 1253 to 1789 at least six doctors of the Sorbonne were constantly employed in giving gratuitous instruction. The high standard of excellence thus maintained by the faculty, and the large number of distinguished scholars who went out from the Sorbonne to fill the highest ecclesiastical and civil offices in every European country, raised this celebrated school to an unrivaled pitch of fame and influence all through the middle ages and down almost to its suppression.

Its controlling power was felt in the contests between the University of Paris and the mendicant orders, Guillaume de Saint-Amour being the chosen advocate of the former and the uncompromising foe of the friars. The Sorbonne was appealed to in the disputes between the civil powers and the papacy, and in the great theological controversies and long schisms that divided the church. It opposed the claims of ultramontanism, decided against the divorce of Henry VIII. from Catherine of Aragon, condemned the doctrines of Luther, Calvin, Baius, Jansenius, and Quesnel, sustained the catholic league against Henry of Navarre, and declared in 1588 that Henry III. had forfeited the crown.

The Sorbonne was specially favored by Cardinal Richelieu, who rebuilt on a magnificent scale the college, lecture halls, and church, besides enlarging the library. The first works printed in France were from the presses of the Sorbonne. These were established in 1469 by Jean de la Pierre, prior of the Sorbonne, and Guillaume Fichet, rector of the university. In 1470 they published *Gasparini Pergamensis Epistolarum Liber*, followed by other publications in Latin, French,

THE NEW SORBONNE, PARIS, THE GRAND STAIRWAY.



THE NEW SORBONNE, PARIS. THE GRAND AMPHITHEATRE.

MR. FRANCIS GALTON, President of the Anthropological Institute.
PROF. G. H. DARWIN, Plumian Prof. of Astronomy, Cambridge.
MR. W. T. THISELTON DYER, Director of the Royal Gardens, Kew.
MR. R. H. SCOTT, Secretary, Meteorological Office.
DR. WILLIAM HUGGINS, Astronomer.
LORD RAYLEIGH, Secretary.
MR. W. H. PREECE, Electrician to Telegraph Department, General Post Office.
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PROFESSOR E. RAY LANKESTER, Prof. of Zoology, University College, London.
MR. W. H. M. CHRISTIE, Astronomer-Royal.
DR. EDWARD FRANKLAND, Chemist.
MR. NORMAN LOCKYER, Prof. of Astronomy, So. Kensington.
PROFESSOR A. W. WILLIAMSON, Foreign Secretary

SIR GABRIEL G. STOKES, President.
SIR JOSEPH HOOKER, Past President.
PROFESSOR J. J. SYLVESTER, Savilian Professor of Geometry, Oxford.
PROFESSOR T. H. HUXLEY, Past President.
DR. ARCHIBALD GEIKIE, Director General, Geological Survey.
PROFESSOR JOHN TYNDALL, Physicist.
PROFESSOR CAYLEY, Sadlerian Prof. of Pure Mathematics, Cambridge.
SIR RICHARD OWEN, Paleontologist.
MR. W. H. FLOWER, C.B., Director of Nat. Hist. Depts., British Museum.
MR. WILLIAM CROOKES, Chemist.

THE ROYAL SOCIETY—A PORTRAIT GROUP OF SOME OF THE MOST DISTINGUISHED FELLOWS.

Greek and Hebrew. The Sorbonne was suppressed in 1789, and at the organization of the modern University of France by Napoleon I. its buildings became the seat of the faculties of science, letters, and theology of the *academie universitaire;* but the faculty of theology is scarcely a shadow of its predecessor.

THE NEW BUILDINGS OF THE SORBONNE, PARIS.

IN England we are still fighting about the question whether London is or is not to have a teaching university. It is significant that Frenchmen have no sort of doubt as to the necessity of such an institution in Paris. During the long and splendid history of the Sorbonne they have had ample experience of the value of a great teaching body in the capital; and the result is that this is one of the institutions in which men of all parties take a common pride.

So long ago as 1855 it was decided that new buildings for the Sorbonne should be erected, but the scheme was not really complete until 1881. It was then estimated that the expense would be 22,000,000 francs—a formidable enough sum, but one which caused no serious difficulty, as the city readily undertook to contribute half of it. The foundation was laid in 1885, and now a considerable part of the work is finished. This was recently opened, in the presence of the head of the state, and the ceremonies on the occasion may be regarded as affording fresh evidence of the enthusiasm felt by educated Frenchmen for all that represents and tends to develop the highest intellectual life of the nation. Every university has been asked to send delegates elected by the students to the celebration; and the state, and the city of Paris, agreed to look upon them as their guests during the ten days of festivity in honor of science. "This part of the programme," says the Paris correspondent of the *Daily News*, "has been well carried out, arrangements having been made with different hotels to board and lodge the foreign visitors at the expense of the Hotel de Ville and the Ministry of Public Instruction. Russia and Germany have not accepted invitations, but the universities of Great Britain, of the Scandinavian countries, of Belgium, Holland, Greece, Switzerland, Italy, Spain, and the United States are represented. There are about 700 delegates from these countries, besides a large number who have come at their own expense."

The *fetes* began on Sunday evening, Aug. 4, with a gala performance of "Faust" at the opera house, which the president attended. On Monday, 3,000 persons assembled in the new amphitheater, an immense hall adorned with frescoes. Each delegation had a standard bearer carrying the flag of his nation, and the members of the various groups were warmly greeted by the public as they advanced to the places appointed for them. At three o'clock M. Carnot arrived, and took his seat on the platform, surrounded by ambassadors, statesmen, and academicians. M. Ferry, as the minister who made the arrangements for the enlargement, was much cheered.

M. Greard, Rector of the Academy, made the first speech. He sketched the history of the Paris University, extolled the events of 1789, and described study as a common fatherland, which had brought together delegates from nearly all the European and American universities. M. Hermite next reviewed the mathematical teaching of the Sorbonne since 1808. M. Chautemps, President of the Municipality, vindicated democracy from the imputation of indifference to culture, and claimed credit for the body represented by him for having founded a chair of French revolution history and a chair of evolution. M. Fallieres, Minister of Education, dwelt on the efforts and sacrifices of the republic for the diffusion of culture. He referred to the moribund condition of the universities on the eve of the revolution, and the want of cohesion between the colleges afterward established, and eulogized the individuality now developed by the provincial universities.—*Nature.*

MEMBERS OF THE ROYAL SOCIETY.

WE give from the London *Graphic* an engraving containing portraits, for the most part very good, of leading members of this time-honored society.

HOW SALT IS MADE.

WE recently had the pleasure of inspecting some of the salt works in the Wyoming and Genesee valleys in this State, and found them very interesting. The industry has grown to vast proportions within a few years, to the great benefit of the consumers of salt, both in giving them superior qualities and in furnishing these at continually reduced prices.

For many years Syracuse was the center of the salt industry in this State, but it is so no longer. There great quantities of salt were and still are made by solar evaporation; but in Western New York the brine is all evaporated by artificial heat. There are two systems in use for doing this. One is by circulating steam through pipes in wooden tanks filled with brine, called grainers; the other is by direct heat from furnaces under steel or iron pans containing the brine. The former is said to make salt at the least cost, while the latter gives salt of a better quality.

We spent more time in examining the works and processes of manufacture of the Genesee Salt Company than any other, and we believe it will be of interest to our readers to be told how salt is there made. These works are at Piffard, in Livingston County, on the line of the W. N. Y. & P. R. R., thirty miles south of Rochester. They are very extensive, and have a capacity, when fully running, of producing 5,000 bushels of salt per day. The rock salt is here found about 900 feet below the surface, and is in layers of different thicknesses, the chief one having sixty-eight feet of pure salt. Above this bed of rock salt there is a constant natural brine flow.

Into this salt the wells are sunk by means of drills. For several hundred feet these wells are cased with eight inch pipe, so as to exclude all flows of water that may have surface or other contaminations. Inside this casing the piping of the well goes into the salt bed, and in it the brine flow rises nearly to the surface. No amount of pumping reduces it below this level, and it has steadily improved in quality since the pumping began. When pumped into the storage tanks, this natural brine is as clear and colorless as the purest spring water. It is fully saturated, containing about twenty-six per cent. (by weight) of salt.

The storage tanks hold about 75,000 gallons each. There are twelve of them. The brine remains in these long enough for the gypsum to settle. Gypsum is said to be universally found with brine both in America and in Europe. The tanks are built upon high trestles, and from them the brine runs into the evaporating pans. These are of steel plate, and are twenty-four feet wide, 120 feet long and about twenty inches in depth. There are five of these, side by side, with wide alleys between them. Beneath them are three furnaces to each pan, where small sized anthracite coal is burned with a strong blast from the steam-driven blowers.

Great skill and care are required to run these fires so evenly as not to vary the temperature of the brine in the pans. As the water evaporates, the salt forms upon the surface, floats there for a moment, and then sinks to the bottom. The size of the crystal is in proportion to the time consumed in its formation. For fine-grained salt, for dairy and table use, a constant high temperature is absolutely necessary, while at lower temperatures larger crystals are formed.

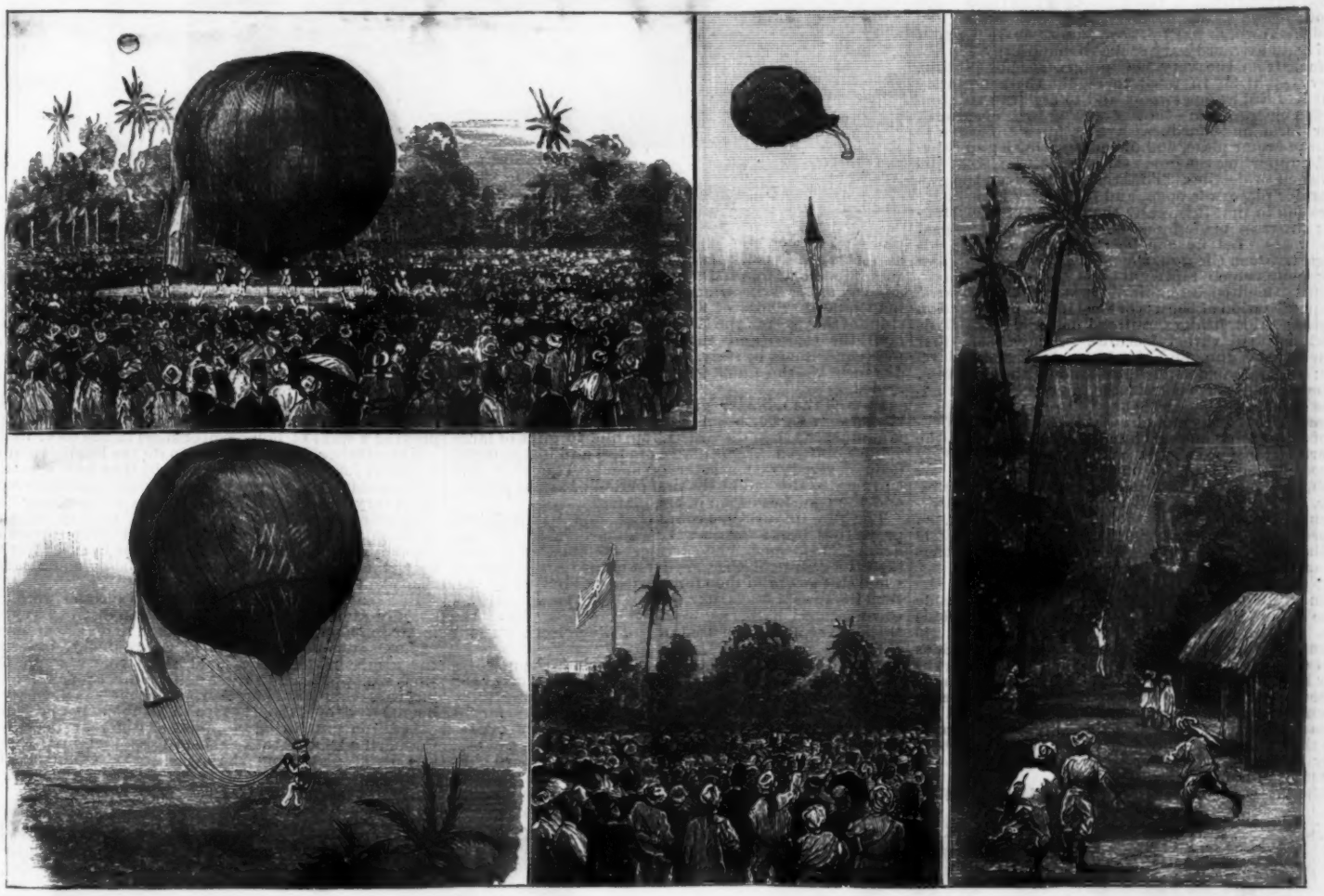
When the salt sinks to the bottom of the brine, it lies upon the steel of the pan, and must be quickly removed, if a high degree of heat is maintained, to prevent its baking there and the pan becoming injured. This is done by men with long-handled rakes, who dexterously draw the salt upon drips by the sides of the pans, where the brine held between the crystals drains back into the pans. These men work in the dense steam rising from the brine, and, stripped to their waists, move about like weird specters. Their work requires a high degree of skill, which only experience can give.

In due time the salt is loaded into handcarts, and is wheeled away and dumped into storage bins, where it remains until the moisture drains away until but little remains. It requires from a month to six weeks for this to be done. Coarse and common salts are then ready for shipment, but salt for table or dairy use has to be further dried by artificial heat. For this purpose it is raised by elevators to the third story of the immense storehouse, where it takes a long journey in great revolving drums, through which strong currents of hot, dry air are steadily forced. We are informed that the company has patents covering the essential parts of these driers, so that they are used in no other works.

After passing through the immense driers, the salt falls upon screens, which separate the crystals according to the purposes for which the salt is desired. It is then packed in linen sacks, branded with the company's name and trade mark, and is shipped to all parts of the United States, and even to foreign countries. Considerable quantities of salt have gone from these works to Australia, where it seems to be preferred to that taken from England.

We were especially struck with the whiteness, uniformity of crystal and clearness of flavor of these salts, made expressly for butter and cheese. We were shown a great number of letters from noted cheese and butter

Filling the Balloon in Government House Grounds—a Pilot Balloon up.



The Ascent. The Critical Moment. Safe on Land.

A PARACHUTE DESCENT AT BOMBAY.

makers, which indicate that this salt must be as good as it looks, and that is saying a great deal. Many of them mention the remarkable fact that it never hardens or lumps, and when used requires no sifting. Many letters joyfully described the great keeping value of the salt when butter is held in storage and when cheese is kept to ripen with age.

In most other sections no natural brine flow is found above the salt bed, or, if it exists, it is too impure for use. There surface water is forced down into the salt, and when it becomes saturated, it is pumped up for use. As nearly all surface waters contain animal, vegetable and mineral matters, the salt produced is necessarily affected thereby.

Near the Genesee company's works is the Retsof mine. A shaft fourteen feet square is sunk into the salt bed and the rock salt is mined and raised to the surface very much as coal is mined. This rock salt is used for cattle and for manufacturing purposes. The Retsof company makes very large shipments from its mine, which is the only one in the United States, except that upon the island of Petit Anse, in Louisiana, where the salt bed is at the surface.

We left the Genesee and Wyoming valleys greatly pleased that an industry affecting the welfare of every farmer and dairyman, and, indeed, of every family in the land, has there been developed in so sound a manner, furnishing this staple article in a degree of purity and excellence nowhere surpassed, and at the lowest price ever known in the history of the world.—*Country Gentleman.*

ARMOR PLATE.*

THE experiment made at Kinburn on October 17, 1855, was decisive. Light was shed, despite the rabid opposition of the partisans of the sail navy, who wished to see nothing. It was during this year that occurred the first serious trials of rifled guns. The artillerymen did not succeed at the first move, but they had entered a fertile field which was to revolutionize naval *materiel* and give an extraordinary scope to metallurgy.

In fact, from the very beginning of armor plating, artillery set itself to work to regain the superiority that it had lost at one swoop, and to find the solution of a double problem—that of giving a projectile of proper form and hardness a live force sufficient to penetrate armor plate, and of constructing a gun capable of supporting the great stress resulting from the use of such projectiles. The struggle between the gun and armor plate was open, and its history is the more interesting in that it is really the history of the astonishing progress made by metallurgy during the past thirty years. Let no one be deceived about it; this struggle between the gun, the destructive element, and armor plate, which represents the spirit of preservation, has benefited humanity. It is to it that we owe the generalization of the use of steel in the construction of engines, ships, bridges, railroad material, etc. This contest has had varied features. Armor plate first conquered the gun, and the latter took a signal revenge; armor plate defended itself, not without success, but to-day, unless it makes more progress, it must admit its defeat.

In measure as the metallurgist increased the thickness of the plating and the resistance of the metal, the artillerist transformed his cannon and successively adopted various systems of rifling, loading at the breech, etc. He modified the proportions of the projectile, and the powder, and finally increased the caliber until, ten years after the adoption of rifling, he had produced guns of a weight that caused some little apprehension among the sailors in the first vessels that were armed with them.

Yet, what was the 9½ inch gun which formed the armament of frigates of the Flandre type alongside of the 100 ton (17 inch) guns of the Italian armorclads Italia, Lepanto, and others, alongside of the 110 ton guns of the British armorclads Benbow, Sans Pareil and Victoria, and alongside of the 75 ton guns of our Indomptable type? To-day, all the powers have adopted that for their naval artillery, and France, in her armament, has regained the rank that she lost for a moment. She for too long a time opposed to armor plate the hooped and tubed cast iron gun, thus obstinately pursuing a fruitless course at the expense of large sums of money.

While the Creusot works were manufacturing steel in large masses and naval constructors were using this metal for the hulls of ships, our naval artillery was ever seeking to utilize its old stock of tools. Krupp and Whitworth were making guns of steel, while we were still discussing the efficiency of this metal. To-day, these errors are no longer but a reminiscence, and the last armorclads put in service, the Amiral Baudin and the Formidable, are armed with 15 inch guns, which, with a charge of 260 pounds of powder, throw a 1,230 pound projectile with an initial velocity of 1,960 feet.

As may be seen, there is a great difference between the 6⅕ inch cast iron hooped and rifled gun that formed the armament of the Gloire and the 15 inch steel guns of the two above named armorclads; and there is just as much difference between the 5 inch iron armor plate of this same Gloire and the 22 inch steel one of the Amiral Baudin.

Iron plates soon showed themselves powerless to resist guns. In measure as the energy of the pieces increased, shipbuilders demanded a greater and greater thickness of metal for their armor plating. In order to give them satisfaction, the fertility of the industrial mind exhausted itself in vain in combinations ever renewed; but the iron plates failed in homogeneousness as soon as a certain thickness was exceeded, because it was impossible to obtain them except by welding, so, as early as 1868, the armor plates that were made were inadequate. Those of 9 inch of the load line of the ships of this period, the Monarch and Invincible in England, the Ocean and Marengo in France, and the Venezia and Roma in Italy, were perforated at a fighting distance by the guns with which these vessels were armed.

In 1876, the monster guns made their appearance—the Armstrong 80 ton and the 100 ton of the Duilio. Metallurgists then discarded iron, and to guns of large caliber opposed armor plates of steel and mixed metal (iron covered with a layer of steel). The year 1876 thus marks the end of the first period of armor plating and the transformation of the plates.

The gun in turn was conquered, and its hard iron projectiles broke against the armor plates. It was again transformed. The artillerist elongated it, modified the nature of the powder and projectile, substituted cast steel and then forged steel for chilled iron, and then the special steels that are now being manufactured. Chrome steel balls, as well known, now pierce the thickest armor plate used up to the present on war ships.

A fact that can but astonish one is that the most interesting experiments in firing at armor plate have been made in Italy. Up to recent years, this young kingdom had remained a tributary to foreigners for its armor plates, but it had not been sparing of experiments with a view to providing its navy with the best means of protection. Let us add that the experiments of the Italian navy have always been made with a scientific perspicacity that gives a high technical value to the resolutions taken. They therefore merit a description.

In 1876, several works were invited to take part in an international competition in the trial of 22 inch plates backed by a wall representing a section of the armorclad Duilio.

Steel for the first time was coming into competition. While Cammell and Brown, of Sheffield, and the French works of Marrel Brothers sent specimens of rolled iron to the polygon of Muggiano, the Creusot works opposed to them two plates of a peculiar steel known as Schneider metal. The tests began with the firing of a 10 inch gun, and were continued with firing in volleys with an 11 inch and a 10 inch gun. They ended with the 17 inch (100 ton gun), which throws a chilled iron projectile weighing 2,000 pounds.

The Italian commission concluded in favor of the Schneider plates, as these alone appeared to it capable of protecting a ship at the load line. Conformably to the commission's proposition, the Creusot works had the furnishing of the plates for the Duilio and Dandolo.

The result of these experiments and the conclusions of the report were the subject of sharp criticism on the part of the English press, which found it hard to admit the defeat of its manufacturers; but specialists on the other side of the channel were not deceived. They understood that in manufacturing iron in large masses they were proceeding in the wrong direction; and so, in order to utilize their stock of tools, they invented what is called compound metal. To make this latter, steel in the proportion of one-third to two-thirds of iron is run over an iron plate raised to a high temperature, and the whole is passed through a rolling mill. But the adhesion of the two metals is rarely complete. In tests with the cannon, traces of separation are frequently observed at the points of breakage, thus proving a want of homogeneousness in the total mass.

Nevertheless, it is necessary to do the English manufacturers justice to say that by 1880 they had succeeded in making compound plates of great thickness having a very hard steel face capable of breaking the projectiles in ordinary use, and of a quality superior to those of the soft steel plates tested with success at the polygon of Muggiano. But, at the Creusot works, important improvements were also being made in the treatment of steel in large masses.

In France, the partisans of the two systems were unequally divided. The administration of the navy, in order to settle the question, decided to make extensive experiments at the polygon of Gavre before ordering the armor plates for several ships that were on the stocks. Appealing to the English and French metallurgists, it, in March or April, 1880, made some experiments full of interest with a 13 inch hooped and tubed iron gun, firing at plates of different makes—a Cammell mixed plate, a Creusot hard metal plate and soft metal plate from the same works, a Marrel iron plate, and a Terrenoire cast steel plate. All were what are called diminution plates.

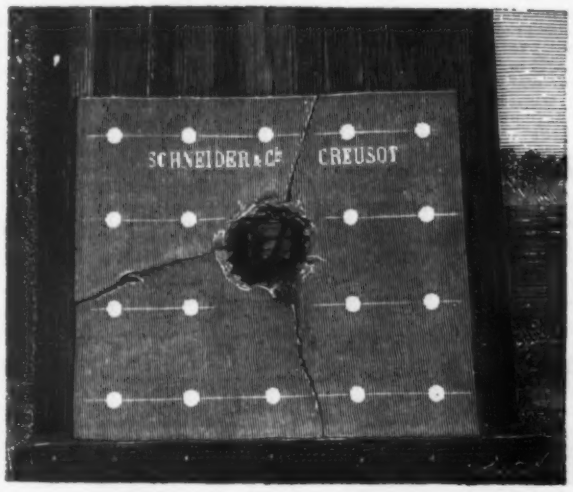


FIG. 14.—CREUSOT PLATE—FRONT VIEW AFTER THE FIRST SHOT.

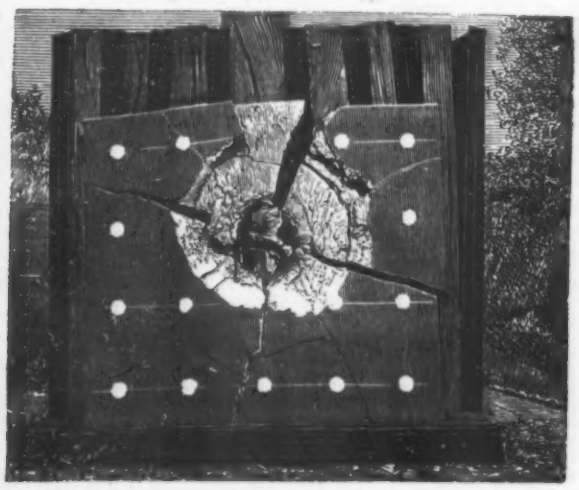


FIG. 15.—BROWN PLATE—FRONT VIEW AFTER THE FIRST SHOT.

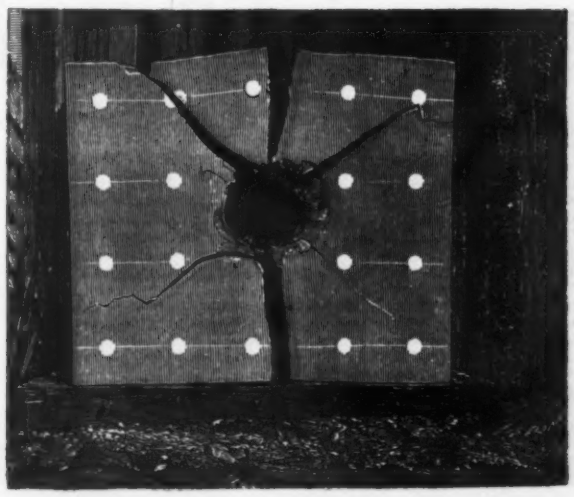


FIG. 16.—CAMMELL PLATE—FRONT VIEW AFTER THE FIRST SHOT.

The commission judged that the Cammell mixed plate, which had supported three blows without the wall being exposed, was undoubtedly superior to the other specimens. After that came the Creusot hard steel plate and the soft steel plate, the Marrel iron plate, and lastly the Terrenoire cast steel plates, which had shown extreme fragility.

* Continued from SUPPLEMENT, No. 713.

The success of the Cammell plate decided the administration of the French navy to introduce the compound metal into France, and so it promised orders to several works on condition that they would get up the necessary tools; but, at the same time, in the presence of the new progress made at the Creusot works, it ordered several lots of armor plates from Schneider & Co. Despite their efforts, French metallurgists have rarely succeeded in producing compound plates comparable with the English ones. The results acquired by the latter at Gavre were followed by numerous failures, which the manufacturer of steel has not ceased to improve.

Thus, Cammell took the furnishing of the armor for the Chinese armorclad Ting Yuen, built in Germany; but the 8 inch sample plate tested at Dillingen was rejected by the German officers who composed the committee.

These incidents attracted much attention in Italy. The armor of the Italia had been ordered at Sheffield on the strength of the English experiments and the affirmation of the admiralty, which held that the compound plates had solved the problem; but as it was desired to fix the conditions of the receipt of the plates that were expected from England, it was decided to profit by firing tests to study the question anew.

Therefore, 19 inch plates were requested from the Cammell, Brown and Creusot works. The programme demanded that two shots should be fired at each of these plates; the first with a live force sufficient to perforate 19 inches of iron, and the second with the power necessary to perforate a 24 inch plate of iron, that is to say, a thickness of iron greater by one-quarter than that of the plates experimented with.

The gun used was a 100 ton Armstrong, one having a chilled iron projectile. At the first shot, the mind of the commission was enlightened. The target of mixed plates was badly damaged, while that of the Schneider plate was unharmed. On the second shot, the Schneider plate again resisted admirably. The Brown plate was broken into six fragments, five of which became loose and fell in front of the target. The effect of the shock on the Cammell plate was still more disastrous—nothing remained of it.

The international contest between a Cammell compound plate and a Schneider metal plate was continued in 1882.

At the same period, experiments were being made at Gavre, France, on some plates designed for several armorclads. On the 21st of December, 1881, a trial was made of a Schneider diminution plate of $\frac{11}{12}$ inches, designed for the Terrible. It was received with "very satisfactory mention," and the commission declared that it "considered it superior to anything that had been made at Gavre to that day."

Later on, among other results, the Creusot steel plates for the Furieux and Amiral Baudin were received with the respective mentions of "passable" and "satisfactory," while the mixed plates designed for the Indomptable had twice the mention of "very mediocre," and the same opinion was passed upon a lot of mixed plates designed for the Requin. The question was no longer debatable when it was one of comparing the resistance of French plates; but a doubt certainly remained in the minds of certain persons who were unable to follow the progress of all the experiments. The English press is very earnest, and is much devoted to national interests. It loudly proclaimed the superiority of the compound plates, and described with emphasis the experiments that had frequently been made upon the Nettle—the vessel charged with the carriage of plates.

When some plates designed for a foreign ship were being tested, haste was made to sing anew the triumph of the Sheffield works. In France, there was nothing like this, but rather a sort of reserve among manufacturers before publicity. At this epoch, the press was indifferent to naval affairs. It was therefore necessary to fight with a strong hand and to have satisfaction twenty times in order to get a chance to be heard.

Once, however, the *Times* made its complaints heard, but, as there was a powerful national interest in play, they were lost in a counter current. On the 25th of May, 1883, a 19 inch Cammell plate was attacked at Shoeburyness with the 80 ton Woolwich gun, having a 1,600 pound Palliser shell. The plate, at the first shot, was broken into five pieces and the backing entirely disjointed. "It is truly discouraging," says the *Times* in a melancholy way. Yes; it was so much the more discouraging in that victory had just been shouted after the experiments made at Amager, in Denmark, in which mixed plates of medium thickness had been tested conjointly with a Schneider metal plate. The conclusions of the Danish commission, which were favorable to the compound plates, raised serious objections. The position of the plates on the targets had been left to chance, because the extreme plates had to be held by only one of their sides. It will be agreed, *a priori*, that chance should never enter as a factor into this kind of experiment, and the plan decided upon at Copenhagen was due to an error of judgment. The method of attacking the plates is so important that it is difficult to understand the reason why the Danes adopted the defective arrangements used at Amager.

However, new experiments were to settle the question definitely. Before giving the order to go to work on the armor plate for the Lepanto, the contract for which was already prepared with the Sheffield works, the Italian Minister of the Navy decided to make a severe test of some plates placed exactly in the same conditions, and to compare the results with scientific accuracy (Figs. 1 and 14 to 17).

Three works sent specimens of their manufacture to Spezia: the Brown, Cammell and Creusot works. The plates were of the following thickness: the Brown, 17 inches; Cammell, 19 inches; Schneider, 19 inches. According to the programme, they were to be attacked: (1) in the center by a 100 ton gun throwing a Krupp forged steel projectile weighing 1,830 pounds, with a velocity of 1,850 feet; (2) at each of the angles, by a 10 inch gun throwing a Krupp forged steel projectile of 400 pounds, with a velocity of 2,300 feet.

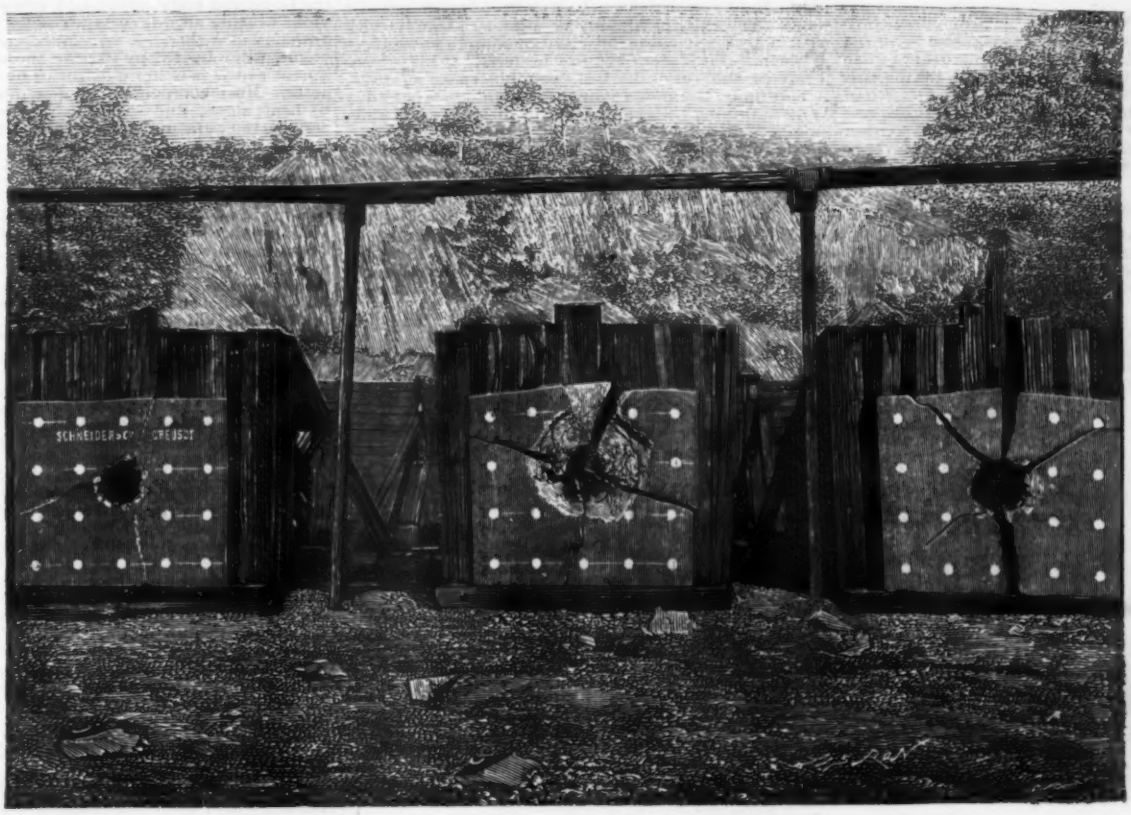


FIG. 17.—EXPERIMENTS IN FIRING AT 19 INCH ARMOR PLATE AT SPEZIA.

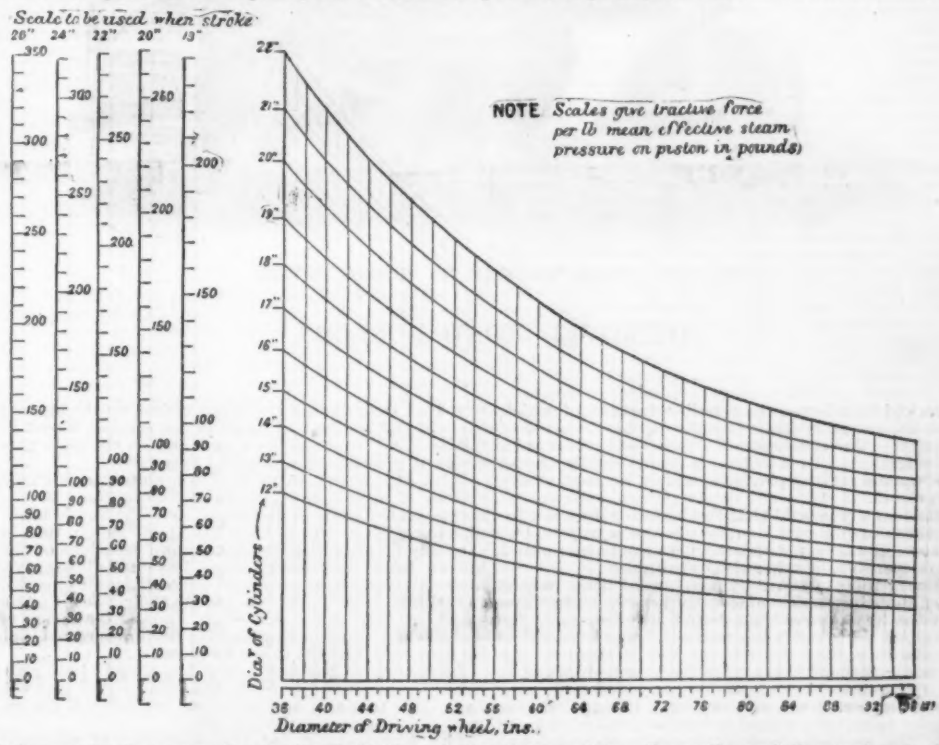
All the plates were perforated; there was no question of that with anybody. After the first shot with the 100 ton gun, an examination of the damages to the targets showed it to be certain that the Schneider plate alone would be in a condition to support the four shots of the 10 inch gun.

The destructive effect exerted behind the targets was very great in the two mixed plates, the steel covering of which was removed in part, leaving a large surface of iron exposed. This is a point that ought to attract attention, for it may be asked whether such stripping would not be frequent in oblique firing, the ordinary kind of firing in naval warfare.

(To be continued.)

TRACTIVE POWER OF LOCOMOTIVES.

THE diagram below gives the tractive power, in pounds, of locomotives per pound mean effective steam pressure on piston, and is one which will be found very useful in solving all questions relating to size of cylinder for given tractive power, length of stroke, maximum diameter of driving wheels, etc., and also for facilitating the comparison of the tractive power of different engines. As an example of the use of the diagram, suppose we require to know what will be the


Scale to be used when stroke
26" 24" 22" 20" 19"
NOTE Scales give tractive force per lb mean effective steam pressure on piston in pounds
Dia^r of Cylinders
Diameter of Driving wheels, ins.

mean tractive power of an engine having cylinders 17 in. diameter by 22 in. stroke, and driving wheels 60 in. diameter. At the point marked 60 in. on the scale of diameters of driving wheels at the bottom of the diagram, with a pair of dividers measure the length of the ordinate from the base line up to the line marked 17 in. diameter, transfer this to the scale to be used when length of stroke equals 22 in., and read off 106 lb. as the tractive force which will be exerted for every pound mean effective pressure on the piston, or $\frac{17^2 \times 22}{60} = 106$. Again, given the diameter of driving wheels, length of stroke, and tractive power, required the diameter of cylinders: Reduce the tractive to pounds per pound of mean pressure, and taking this value on the scale to be used for the given length of stroke, set it off over the given diameter of wheels, and read off the diameter of cylinders required. Other uses of the diagram will readily suggest themselves to locomotive engineers.—*G. R. B., in The Engineer.*

IMPROVED ROLLERS.

WE illustrate two novel forms of roller, shown at the Royal Agricultural Exhibition, Windsor, by Mr. Edward Pratt, of the Albert Iron Works, Uxbridge. Fig. 1 shows a roller designed for manual power and Fig. 2

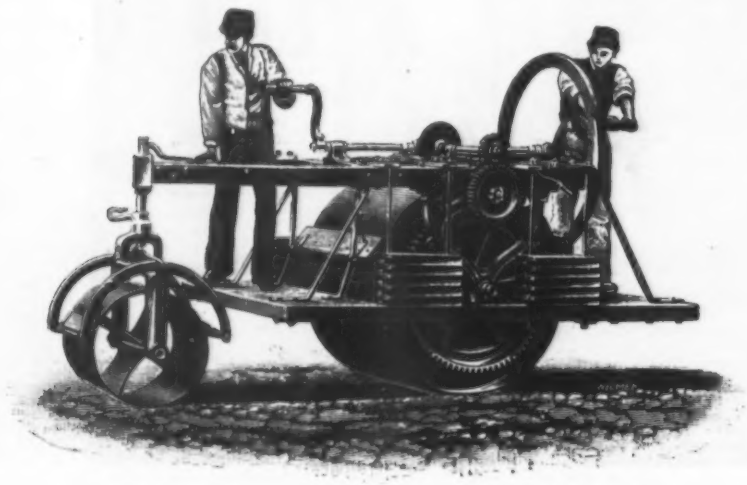


FIG. 1.—ROLLER WORKED BY MANUAL POWER.

FIG. 2.—ROLLER WORKED BY HORSE POWER.

one worked by a horse, the peculiar feature of which is that the animal is carried by the machine, instead of drawing it. The construction is sufficiently clear from the illustrations. In the horse power roller the horse stands upon a moving platform, which he continually treads round.

It need hardly be said that the inventor does not intend these machines to supersede steam rollers, but they are applicable in districts where the former would be too expensive, or otherwise unsuitable.

Ordinary rollers drawn by men are of little use, as they cannot be made sufficiently heavy, while those drawn by horses have been found unsatisfactory for reason that the speed is too great, it being essential to efficient action that the motion should be slow. By the use of gearing this end can be attained, while at same time a heavy roller can be propelled with very little power, and taken up steep hills. The speed may be varied to suit the weight carried and the work to be done. The manual power roller can be weighted to 5 tons; that for horse power up to 8 tons, while, exclusive of loose weights, its weight is 4½ tons. This type of roller has the advantage that no footmarks or displacement are caused by the animal's feet, a feature of particular value for lawns and gravel paths.—*Industries.*

DETECTION OF MERCURY IN MINERALS.

By ALEXANDER JOHNSTONE, F.G.S. (London and Paris), Assistant to the Professor of Geology and Mineralogy in the University of Edinburgh.

A STUDENT of modern mineralogy has neither the time nor the inclination to determine qualitatively the metallic and non-metallic elements of the minerals which are continually being brought under his notice by the tedious, if accurate, ordinary wet way analytical methods of the chemist. And yet it is of the utmost importance that he should be able to identify with perfect accuracy the elementary or simple substances of the naturally occurring raw materials of his science—but in the very shortest possible space of time. Accordingly, the most advanced mineralogists of to-day in determining the composition of their ores and veinstones very properly make use, as much as possible, of the rapid blowpipe methods of testing, such as heating, with and without fluxes and other chemicals, in partially closed tubes, in open tubes, on charcoal, platinum, aluminum, in borax, boracic acid, etc. The whole department of blowpipe analysis, however, has been for the last score of years so sadly neglected, not only in this country and America, but also in Germany and Scandinavia, where its foundation was laid at the end of the last and the beginning of the present century, that the mineralogist is not unfrequently, against his will and the best interests of his science, forced to fall back, for confirmations at least, on the slow processes of present day analytical chemistry.

With the object in view of completing a working system of quick and certain determinations of elements, on the basis of Berzelius' and Plattner's blowpipe operations, the author has spent much time in carefully investigating the nature and reactions of the known tests, and where these have failed to give, under all circumstances, rapid and satisfactory results, in seeking for new ones to supply their places. As a result of this search for other and better means of identification two new tests have been discovered, one for antimony and the other for mercury.

An account of the former test has already been published in the *Chemical News*, vol. lviii., p. 296, and vol. lix., p. 15; to give a description of the latter is the object of the present communication.

This new method for the detection of mercury, which has been in operation in the author's laboratories for the last six months, depends on the fact that, when a small quantity of iodine in the form of vapor, *newly liberated* from a compound, is allowed to impinge on metallic mercury, it instantly converts it into the characteristic scarlet mercuric iodide. The method of applying the test and the various preliminaries necessary in every case of blowpipe analysis are briefly detailed below.

The author may here mention that he has very carefully examined all known mercury minerals, and other minerals containing only the slightest trace of that metal, by his process, which in every case has rapidly yielded very satisfactory results.

The first operation in blowpipe analysis consists in heating in a narrow glass tube, closed at one end, first the powdered body *alone*, and afterward, if the previous heating affords certain results, the same with the *addition of a flux*. A substance containing mercury yields, when heated by itself in the closed tube, a sublimate which is either metallic or non-metallic in character. Most compounds of mercury are decomposed by heat alone, and so furnish, when subjected to a certain temperature, the former sublimate; but mercu*rous* chloride and bromide, and mercu*ric* chloride and iodide, and to a certain extent the sulphide also, are volatile without decomposition, and accordingly produce sublimates of non-metallic luster. All compounds of mercury, however, when dry and intimately mixed with three times their bulk of ordinary anhydrous fusion mixture ($K_2CO_3 + Na_2CO_3$), yield under the influence of heat metallic mercury, which condenses on the cooler portions of the tube above the assay. This metallic sublimate, when unmixed with other matters (metallic or otherwise), and in large quantity, usually shows distinctly enough its characteristic globules; but when impure and small in amount the globular character is not at all evident, and it may then be quite easily mistaken for arsenic alone, and sometimes, though rarely, for antimony. In the latter case this new process will afford quick and certain means of determination, while in the former it should also prove useful, as trustworthy confirmation. If the substance, then, which is undergoing examination gives with, if not without, the aid of flux a metallic sublimate, pour into the tube two drops of concentrated nitric acid and immediately afterward a single drop of a fairly strong solution of potassium iodide in water. The nitric acid *at once* splits up the iodide of potassium, and the iodine is liberated in fumes which act on any mercury in the sublimate or in the assay, and *instantly* produce the unique scarlet iodide of mercury, which is largely thrown up against the sides of the tube. The antimony tri-iodide produced in like manner is brownish in color, and becomes yellowish after exposure to the air for some little time. The arsenic tri-iodide is yellow, and this, as in the case of mercury, forms at once; but if the bottom of the tube containing the excess of nitric acid be heated slightly the fumes from that body quickly decompose the iodide, and a spongy dark gray mass of arsenic is driven all around the upper part, at least, of the tube. In the same way the nitric acid quickly decomposes the antimony iodide, while it does not act at all *nearly so rapidly* on the mercuric iodide. The table below shows perhaps more clearly how this test should be applied in the ordinary course of blowpipe analysis.

Table for the Detection of Mercury in Minerals.

a. Heat the powdered substance in a small piece of hard glass tubing (say with a ¼ inch bore) closed at one end.

1. A *metallic* sublimate is produced. Proceed further by *b*.

2. A non-metallic sublimate is formed. Heat a fresh portion of the substance *mixed* with about three times its bulk of fusion mixture. A metallic sublimate forms. Proceed further by *b*.

3. There is no evidence of the slightest volatilization other than water. *No* mercury is present in the mineral.

b. Pour into the tube containing the metallic sublimate and assay *two* drops of strong nitric acid, then at once *one* drop of potassium iodide solution, and heat the bottom of the tube *a little*. A scarlet mass forms and remains on the sides of the tube. Mercury is present in the body tested.

Detection of Very Minute Quantities of Mercury.

When the mercury occurs in very minute quantities, the metallic sublimate described above may not be perceptible on the sides of the glass tube. In this case, when only the *merest traces* of mercury are looked for in the substance, proceed as follows: Place in the closed tube, as already detailed, the mixture of powdered substance and flux, and introduce on the end of a stout wire a small piece of gold leaf, which should be held just over the surface of the mixture. Now apply heat for a minute or so. *Any* mercury present will be volatilized, and the vapor will combine with the gold to form a whitish amalgam. Take out the wire with the gold leaf on its end after sufficient heat has been applied to the mixture in the tube. Touch the surface of the leaf which faced the assay with a single drop of concentrated nitric acid, and on the top of this add immediately a drop of potassium iodide solution; the fine scarlet iodide will at once very distinctly appear on the amalgamated surface of the gold leaf if any mercury whatever was present in the body subjected to examination.—*Chemical News.*

DETERMINATION OF THE THICKNESS OF COVER GLASSES ON MOUNTED MICROSCOPE SLIDES.

FIRST some cover glasses of known thickness, as measured by ordinary methods, are taken. With a microscope the upper and lower faces of one of them are observed, which may previously be sprinkled with a little dust. The movements of the micrometric feed screw, which have to be made for this purpose, are noted, a given eyepiece and objective, a fixed length of tube, and also a definite illumination, having been adopted. Dividing the known thickness of the cover glass, expressed by μ, by the number of divisions expressing the movement of the micrometer screw, a coefficient is obtained, which is to be used in subsequent measurements.

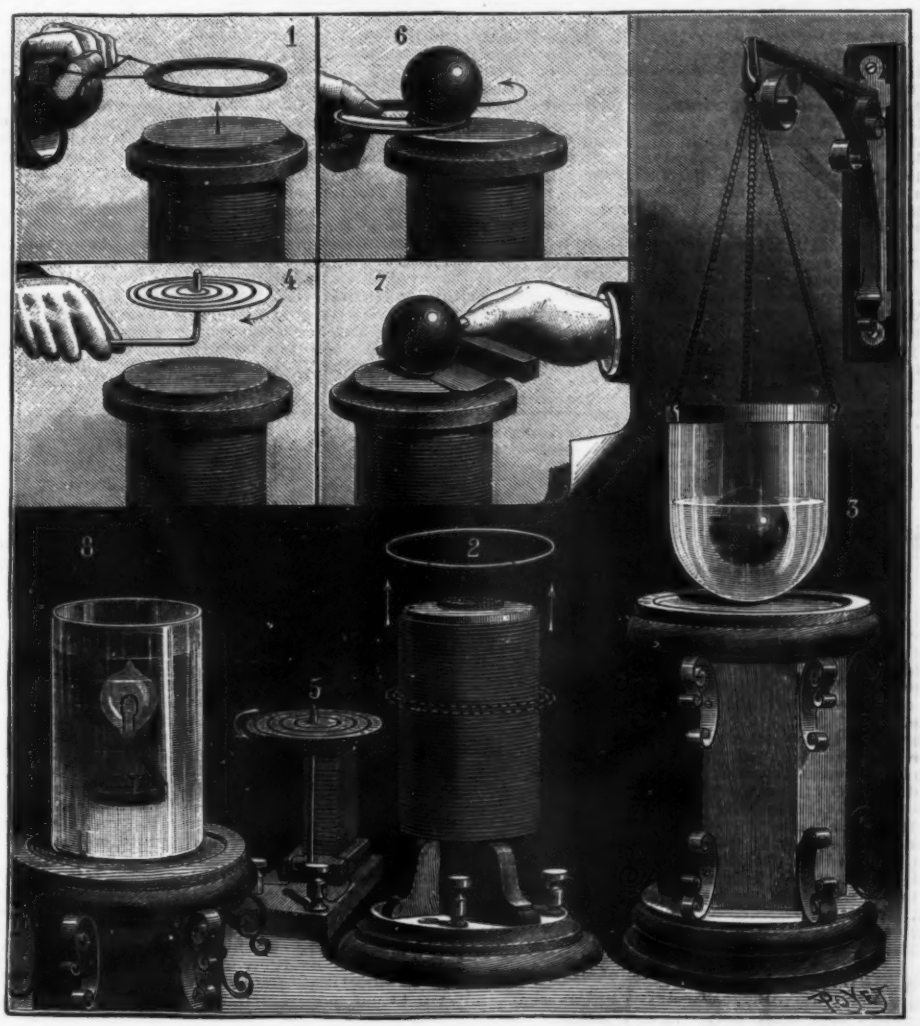
When the cover glasses on mounted slides are to be measured, both faces are observed through the microscope, the movement of the micrometer feed screw is observed, and this multiplied by the coefficient already determined will give the thickness in terms of μ of the

glass. It is of course understood that in this operation the eyepiece, objective, length of tube, and method of illumination should be the same as at first. In order that the eye in all the observations shall exact the same focusing, it is well to place in the eyepiece some fixed object, for example, the micrometer.

Suppose, for example, we have worked with the Zeiss objective D D tube, 155 mm. long, and an illuminator with a diaphragm of 8 mm. aperture, and with test cover glasses 0·146, 0·168, 0·187, and 0·220 mm. thick and have found for the movements of the micrometer screw 33, 40, 45 and 52 divisions; we will have $\frac{146}{35} = 4{\cdot}17$; $\frac{168}{40} = 4{\cdot}20$; $\frac{187}{45} = 4{\cdot}16$; $\frac{220}{52} = 4{\cdot}23$, giving a mean coefficient 4·20.—*Dr. S. Czapski, in Zeitschrift fur wiss. Mikroskopie.*

ELECTRO-DYNAMIC REPULSIONS AND ROTATIONS.

THE action of currents upon currents was discovered by Ampere in 1820, shortly after the fundamental experiment of Oersted. The illustrious French physicist recapitulates all the laws of it in a classical formula that bears his name, and that permits of foreseeing the direction of the action and the amplitude thereof for two currents of any form, as well as the action of a current upon the same.



ELECTRO-DYNAMIC REPULSIONS AND ROTATIONS PRODUCED BY ALTERNATING CURRENTS.

Ampere, however, did not, and for a sufficient reason, touch upon one of the most interesting cases—that of the action of two currents, the second of which is induced by the first, since, at the epoch of his researches, induction was unknown. Even after Faraday's discovery in 1830, the question remained entire, and these peculiar effects were not studied for the first time until 1884, when Prof. Elihu Thomson, of the United States, discovered them.

Since that epoch he has studied and extended them and has succeeded, thanks to the alternating current machine, the use of which is now so widespread, in uniting them into a most interesting group of experiments that have called forth the admiration of scientists and the astonishment of the numerous visitors frequenting the gallery of Liberal Arts at the Universal Exposition.

We propose at present to describe the most interesting and striking of these experiments, reserving for a future article a certain number of applications which well show that these studies have a practical value at least as great as the interest, as regards curiosity, that they present.

Let us, in the first place, examine the general principle upon which these experiments are based. When an iron core is surrounded with a bobbin traversed by alternating currents, it becomes periodically magnetized in one direction and the other and produces a flux of magnetic force, which, starting from zero, increases, passes through a maximum, decreases, becomes null again, changes sign, and again passes through the same phases, but in an opposite direction. In appropriate alternating current machines, this flux may change direction very rapidly, even up to two and three hundred times per second.

If, in front of this iron core, we arrange a copper ring whose plane is parallel with the magnetizing spirals (No. 1), the variable flux traversing this ring will induce intense energetic currents, and these, if the ring is held in place for a few minutes, will develop a sufficient quantity of heat to raise the temperature of the ring to such a point that it can no longer be held in the hand. Lenz's law teaches us that induced currents must be of such a direction every instant as to be opposed to the variation in the flux of force produced by the primary or inducing bobbin.

Reduced to this simple phenomenon, the induced current would, so to speak, be set loose, with respect to the inducing current, by a quarter period, and under such circumstances, the sum of the attractions would be precisely equal to the sum of the repulsions; there would be no attractive or repulsive action between the two circuits by reason of symmetry. This, in fact, is not so, because the current induced in the secondary circuit puts itself in opposition to its own establishment, by virtue of the phenomenon known as self-induction. The resulting induced current is retarded or started by a certain fraction of the period, and symmetry no longer exists. The sum of the attractions is, therefore, inferior to the sum of the repulsions.

The repulsion becomes dominant, sufficient even to cause the ring to be held suspended in space against the forces exerted by gravity. This repulsion is so energetic that it is materially impossible to place the ring or a copper disk upon the iron core (or, rather, upon the stand in which the core is hidden) and to abandon it to itself; and it is with no little surprise that one sees escaping through the tangent all these objects that are deposited upon the top of the stand, and that obstinately refuse to lie there after they are left to themselves.

No. 2 of the figure shows a variant of this experiment. Upon placing a copper ring around the center of the core periodically magnetized by the alternating current, the ring, when left to itself, jumps vertically and rises to a distance of 16 inches above the core.

These experiments bring into play electro-dynamic repulsions only. The phenomenon may be complicated and very curious rotations be produced by rendering the field unsymmetrical.

To this effect we place upon the iron core a half disk of copper which covers just half of it. The currents induced in this disk perform the role of true magnetic screens that almost completely suppress the flux of magnetic force in the region situated above it. On arranging a copper disk, mounted upon a pivot, beneath the iron core, in the region in which the periodical magnetic field has been partially suppressed, the disk is repelled in the region where the flux is intensest. It inclines and takes on a rapid rotary motion around its vertical axis (No. 4).

The same phenomenon of rotation occurs likewise with an inducting apparatus having a smaller core and placed upon a single half of the disk (No. 5), care being taken to prepare a screen of which one of the sides is arranged radially so as to make the field unsymmetrical. The direction of rotation will always be toward the screen.

Rotations and repulsions may both be produced by means of a hollow copper sphere placed in a glass vessel containing a certain quantity of water (No. 3). The sphere will be repelled, and, at the same time, take on a rapid rotary motion that persons not familiar with the phenomena of induction will be unable to explain.

The same copper sphere placed upon the stand (the semicircular screen being hidden in the cover, of course) gives loose to varied motions—rotations, stoppages, and shiftings—the diversity of which is due to the relative position of the screen, of the core of the sphere, and of the plane upon which it performs its evolutions (No. 6). It is possible also to cause the sphere to revolve *in situ* by placing it upon a copper rectangle forming a screen, and in which there has been formed a small spherical cavity in which the lower part of the ball rests without the repulsions being strong enough to dislodge it (No. 7).

A final experiment (and not the least curious one) exhibits both the phenomena of repulsion and induction in a striking manner.

The ring of No. 1 is replaced with a small annular bobbin of insulated wire whose extremities are connected with the filament of an incandescent lamp (No. 8). The whole is put into a vessel filled with water and arranged above the inducting system. On sending an alternating current into this inductor, the incandescent lamp is immediately lighted, while, under the influence of electro-dynamic repulsions, it tends to rise to the surface and stops in an intermediate position such that the repulsion, plus the hydrostatic thrust, balances the weight of the lamp and of the bobbin. The lighting of this lamp in the water, without apparent external communication, forms one of the prettiest and most striking experiments that can be performed for showing the phenomena of induction at a distance and their transmissibility through the majority of media.—*La Nature.*

[Continued from SUPPLEMENT, No. 713, page 11394.]

CABLE TELEGRAPHY.*

By PATRICK BERNARD DELANY.

I HAVE explained to you how a series of impulses of like polarity may appear as a straight line on the strip at the receiving end, according to the frequency with which they follow each other. So also may regular reversals become almost a straight line if they are sent in sufficiently rapid succession, and they might be sent so quickly that no current at all would reach the receiving end, the discharge from one completely obliterating the next. They would strangle each other in the cable. I am convinced, however, that if each signaling current is immediately followed by a neutralizing current of electromotive force, adjusted to the static discharge, the speed of signaling may not only be greatly increased, but the received marks will be unmistakable. In support of my claim, that by keeping the cable in a state of stable equilibrium by the neutralizing impulses, I would state that early last summer I transmitted 680 perfect impulses over a cable of nearly 1,000 miles in length, having a resistance of 13,000 ohms and an electrostatic capacity of 240 microfarads, and this with 8 volts—just one-half of the electromotive force used on this cable ordinarily. This is equal to more than thirty words per minute, and the record was as even as if it had been engraved. In September last, I made two experiments over the Anglo-American cable between Duxbury, Mass., and St. Pierre, island of Miquelon. This cable is 878 miles in length, has a resistance of 8,300 ohms and a capacity of 256 microfarads. The result of these experiments, hurried and unprepared as they were, I have endeavored to bring to your attention on a small scale by having the records reproduced in *fucsimile*. You will find them on the sheet.

Owing to the faint lines made by the recorder, and to the fact of the ink being blue, it was necessary before photographing to go over the strip with pen and ink, which has, to a considerable degree, robbed them of their smooth outline, so that they do not appear to as good advantage. If you will look at the sheet, I will give the record of each specimen beginning at the top. Number 1 is a portion of the Continental alphabet, not sent over the cable, but made locally at Duxbury by the present system of transmission, and by throwing the duplex a little out of balance. It may be considered an ideal specimen. The dots are above, the dashes below the horizontal line, represented by the long straight lines between each letter.

The dots you will remember are all made by one polarity of current, the dashes by the other. No signs of the clogging effect of static capacity are visible in this strip, because the signals were not sent through the cable. Number 2 is by my system of transmission, made under the same conditions. My transmitter puts both dots and dashes at the top, or above the horizontal line. Telegraphers must bear in mind that this is the Continental code, several letters of which differ in construction from our American Morse. I consider the foreign alphabet better than ours. There are no space letters, consequently less liability to error. Our code is faster, however. The Continental C is an American J; our Q is their F; an American X is a Continental L, and so on. It is somewhat puzzling for a sound-reading operator, knowing both alphabets, to read first one and then the other by sound without confusion. I have had some experience with this sort of thing myself. On one occasion I asked an English operator over the wire how my system was working. When he answered back "axx fight," I was content. Now, telegraphists will recognize a dot and a dash for A. Dash and three dots for B, and a dash dot, dash dot for C, dash and two dots for D, one dot for E, etc. Specimen number 3 was received over the Anglo-American cable at Duxbury from St. Pierre. By the long waits between the letters you will see that it was sent at a very slow speed, perhaps eight or nine words per minute. Here we have the effects of choking up of the cable by succeeding impulses of like polarity beautifully illustrated. Observe letter B—a dash and three dots. The lower loop is the dash, and the undulations at the top the three dots. Compare these with the letter B in specimens 1 and 2, which were made on a local cir-

* A lecture delivered before the Franklin Institute, Monday, March 11, 1889.

cuit. The dots in D, F, H and I show the same difference, also the dashes where they succeed each other as in G—two dashes and a dot. Now you will see that if the cable had not the capacity for storing electricity, the record 3 would be like 1 and 2, plain and rapid.

You may say you do not see in specimen 3 the step-by-step feature referred to awhile ago as resulting from successive dots of like polarity. It is because the cable is not a very long one—less than 900 miles—and the speed at which this record was made was so slow as to allow the siphon to drop down between each dot.

I will call your attention to this effect again in specimen 4, sent across the Atlantic. This is the alphabet complete. B, D, H and I show what sort of a passage the poor struggling dot has to contend with coming under the Atlantic. If you will examine this closely, you will see the original line of dots in some places where the tracing pen went slightly to one side. The straight line at the end is the horizontal or neutral line made by the recorder when there was no current in the cable. The break-up in the middle, which looks like the splutter from a pen, was probably caused by a jolt of the table or a jarring of the floor. All the other specimens are some of my own transmission from Duxbury to St. Pierre. These specimens are odds and ends, picked up after the best specimens had been distributed. I have a number of specimens pasted in my book collection here which are infinitely better than those shown. Had it been possible to photograph them without inking them over, I would have done so. In fact, none of the specimens shown you represents the best adaptation of my system of transmission, but I will be glad to show those interested cable strips that any telegraph operator can read, sent at twenty to thirty words per minute.

Specimen number 11 was at the rate of thirteen and one half words per minute. You will notice a great distance between the dots in the specimen and those in specimen 3, sent by the present system from St. Pierre to Duxbury, and at a speed of not over ten words per minute. You can judge of the relative difference in speeds by the condensation or elongation of the characters on the strip. The paper runs through the instrument at an even speed always.

Specimen number 8 was at the rate of eighteen and four-fifths words per minute. The first letter is G, the next L. The photograph process has made the printed letters indistinct.

Specimen 26 was at the rate of twenty-six words per minute. This specimen, as well as 27, are according to the American code. The pen-tracing has injured them badly. They have been reduced one-third by the photograph.

Owing to a misunderstanding, I had but one-half the battery that I was entitled to when these specimens were made. All these things combined is the cause of the small undulations, although the specimens I have in my book are very plain, even number 27, which was transmitted by a Western Union operator who could not send a word by the two-key or cable system. The speed of this 27 specimen was a fraction over thirty-four words per minute. You will see that, even in this specimen, the dots are quite as distinct at thirty-four words per minute as they are in specimen 3, at ten words per minute, and 3 had double the electromotive force behind it that was given to 27.

The last two specimens, those without numbers, are perfect *facsimiles* of my best work between Duxbury and St. Pierre. Every dot is carefully reproduced. The first of the two, "Now is the winter," etc., was transmitted at the rate of twenty-two and one-fifth words per minute, five letters to a word; the other, at the rate of twenty words per minute. The transmission in both cases was made *direct* to the cable, not through condenser, and with 100 microfarads condenser connected to the intermediate segments for the purpose of neutralizing the static discharge in the cable.

I was compelled to take the condenser out of the cable for this purpose, it being the only one available. These, as these two records plainly show, were by far the best conditions for working, and this is the arrangement with which I hope to work the Atlantic cables by sound, at no very distant day.

A study of these specimens will, I think, show conclusively the difference between merely breaking the circuit, depending on the drop in the potential of the cable for the signal, and reversing the current each time that a signal is sent, thus drawing the siphon to the other side of the horizontal line.

I wish to call your particular attention to one result obtained between Duxbury and St. Pierre with my system of transmission, of which I have no wavy tracing to show you. It was not that kind of a result. I sent twenty words per minute for five consecutive minutes, and every dot and dash was received perfectly in St. Pierre *by sound*. At twenty-four words per minute, St. Pierre reported the work a trifle shaky, but the gentleman receiving reported that he had but little experience in adjusting the Brown and Allen relay, which was connected on for the occasion. I am confident that this circuit can be worked perfectly by sound at thirty words per minute. Repeated efforts during the past twelve years have failed to get more than three or four words per minute over this cable by sound.

If you will now take up the diagram of the transmitter and connections which you have, you will find no difficulty in following me while I explain the method and theory of the instrument. (See Fig. 5.)

A represents a receiver at the distant station. An ordinary polarized relay is shown, but it might be a mirror instrument or a Thomson recorder, both of which have been described, or any other receiver. One side of the relay is connected to earth. To the other side is connected the line, L, or cable. This line is connected to the revolving trailer, T, of the polarized transmitter, PS. The trailer is carried by the spindle of star wheel, C, revolved by the pallet end of the armature of PS. *Cd* is a condenser connected to the plate which projects between the segments in the circle. There are two sets of segments, *e* and *f*, in the circle besides the plate segments. Set *f* is connected to insulated contact, *f'*, under the front of the key. Segments, *e*, are connected to the insulated contact, *e'*, at the other end of the key. Contacts, f^2 and e^2, are connected respectively to the positive and negative poles of a main transmitting battery, MB, which is grounded in the middle. The key is connected to the polarized transmitter, PS, thence to the middle of local battery, SB, the ends of which are connected to the contacts, *c* and *c'*, under the back and front ends of the key. As everything now stands, the cable is entirely disconnected. The operation is as follows: If the key K be pressed down, the positive pole of battery, MB, is connected to the cable through contacts, f^2 and *f'*, and segment, *f*, upon which the trailer is resting. When the key reaches contact, *c'*, which is its limiting stop, the local circuit of magnet, PS, is closed and the armature thrown to the right, which moves the trailer off segment, *f*, and breaks the connection between the cable and the main battery. Now, then, if you will look closely, you will see that the trailing finger is slanting, so that it bridges segment, *f*, and the intermediate or plate segment connected to the condenser while it is passing from segment, *f*, to the next segment, above which is one of the *e* set, and in doing so connects the positive pole of the main battery, MB, to the condenser, thereby charging it. When the trailer leaves segment, *f*, and touches only the condenser segment, the charge which the condenser received, while the trailer bridged the two segments, is sent into the cable and meets and neutralizes the static discharge created by the impulse which went into the cable when the key was closed and the trailer was on segment, *f*. The trailer does not stop on the condenser segment, but passes over in one movement of the armature of PS to the next segment group, which is connected to the contact, *e'*, at the back of the key.

Now, if the key be raised, the negative pole of the main battery, MB, is connected to the cable through contacts, e^2 *e'*, segment, *e*, and the trailer. Immediately that the key reaches its limit, contact, *c*, the local battery, SB, is reversed through PS, and the armature moved to the left again, which terminates the contact of the negative pole of the battery with the cable, charges the condenser and discharges it into the cable as before, thus neutralizing the static discharge coming out of the cable from the negative impulse sent in. In this way, signaling impulses of alternative polarity are sent into the cable, and discharge impulses from the condenser neutralize the static charge in the cable.

The force of the condenser discharge may be adjusted to the capacity of the cable by the use of resistance in the condenser circuit. You will observe that the duration of the contact of the cable with the main battery is determined by the time *f' f²* or *e' e²* come together in advance of the local contacts, *c' c²*, which reverse the circuit of the transmitter, PS, plus the time required for the trailer to pass off the segment. This time may be lengthened or shortened, within limits, by adjusting the key contacts. I have, however, a plan for lengthening the duration of contacts, which affords a much wider range, and by which the impulses may be adapted to any length of cable.

THE DELANY LINE ADJUSTER.

I presume that nearly everybody knows that land telegraphs work much better in dry weather than in wet. Every one here must be electrician enough to appreciate this one fact, after all they have heard this evening about the current running down the poles. A little loss, as I have told you, is a good thing, but a rainy day is too much of a good thing for the telegraphs, as it robs the wires of too much current. In such weather the instruments need careful adjustment. At way stations the operators are not usually as proficient in this regard as they might be. Their instruments being out of adjustment, they do not hear other stations calling them, and if they have a message to send, they "break in" on the work going on over the line, calling away and not hearing the answer. How often have we been forced to listen for an hour at a time to uninteresting conversations going on between two oblivious youngsters, while life and death messages hung on the hooks, waiting for them to finish or adjust their instruments! I will not ask how often we have been there ourselves, for we have the floor, but all must admit that interference and failure from causes of this kind are the loudest crying evils of telegraphy. This adjusting system will do away with the difficulty thoroughly, for, so long as the terminal stations are adjusted, all the intermediate instruments *must* respond. Here we have an excellent diagram of a line between Philadelphia and New York, with Trenton and New Brunswick shown as way stations.

There are, I suppose, forty telegraph stations between Philadelphia and New York. So many instruments in a line make it work badly.

Now, if a rainstorm comes up, the current from the main batteries at Philadelphia and New York runs down the poles to ground. If the rain made a perfect earth connection, instead of a partial one, of course Philadelphia could work with no one beyond the point at which the line was wholly grounded. If we should run a wire from line to earth between Trenton and New Brunswick, Philadelphia and Trenton could communicate with each other, but could not reach New Brunswick or New York. In the same way, in bad weather, a station near Philadelphia—Frankford, for instance—will have no difficulty in working with Philadelphia, but, owing to the partial ground connection beyond him, he cannot get Trenton, New Brunswick, or any other station so well. It might be that, although adjusted for Philadelphia, his instrument would remain silent when New York was working. If he adjusted his instrument properly, so as to get New York, he could also work with Philadelphia on the same adjustment, but operators do not always exercise this discretion.

Now it is just here where this adjuster comes in and insures against the carelessness or inefficiency of the operator. After going over the diagram on the paper, I will create an artificial rainstorm between Trenton and New Brunswick, and prove to you that this little instrument keeps things straight all along the line. Please look at the diagram, Fig. 6. The instrument, A, is the adjuster. It is the only addition to the usual outfit. The key, K, at Philadelphia, is down or closed. The main battery goes to the segment plate upon which the trailer is resting, through the trailer to the relay, and thence on through the instrument at Trenton and New Brunswick to the New York relay, to the segment of his adjuster, through the trailer to the key, K, and main battery to earth. Here we have a closed circuit. Now, ordinarily, when Philadelphia wishes to send to New Brunswick, or any other station, he begins by opening his key, thus disconnecting his battery from the line.

This causes all the relays and sounders on the line to respond if they are adjusted, but if it be a bad day, and there be considerable connection to ground down the poles, New York's battery, being still connected to the line, finds its way to the ground all the way to Philadelphia and makes a circuit for the instruments at New Brunswick and other stations along the road almost as strong as before the withdrawal of Philadelphia's battery, consequently New Brunswick's instrument remains silent and the operator does not hear Philadelphia call him, or Philadelphia may be sending to Trenton or New York, but New Brunswick, thinking the lines free, may call Philadelphia and abuse him for not answering calls promptly. This is what is happening every rainy day all over the country, but it cannot happen under the organization before you, for when Philadelphia opens his key he not only takes his own battery off, but if New York be adjusted, the battery at that end is disconnected also, only for an instant, but sufficient for the purpose, as the line is left with absolutely no current for a moment, during which every relay on the line must respond. I will not attempt a detailed description of the operation. It is not necessary.

FIG. 6.

You see that when I put in a partial earth connection between Trenton and New Brunswick, and with the adjuster at New York made inoperative by throwing the switch over to the left, New Brunswick's instrument does not respond to Philadelphia's call as it did before the rainstorm began. Trenton gets Philadelphia all right, because he is between Philadelphia and the storm. New York gets Philadelphia because his instrument is adjusted. If New Brunswick would pull up on his relay spring he would hear Philadelphia also, but he hears New York and imagines he is all right. Besides, he heard Philadelphia before the rain soaked the poles and covered the insulators with a sheet of water. Now I will throw the switch of New York adjuster over to the right. Let us see what effect it has on New Brunswick. You see his instrument works now all clear, and will continue to do so no matter how hard it rains. So will all the instruments on the line. There will be no more interference and no more calling a station for hours at a time. If an operator breaks in or fails to answer promptly, he can't say that his instrument was out of adjustment. The adjuster says no.

I have *talked* so long, I will say a word to you with my fingers on the electric light bulletin. The simplest telegraph in the world. Everybody can send and receive, and if the letters on the transparency be large enough, announcements may be read a mile away.

There is an electric lamp behind each letter, and all the operator has to do is to press the button of each lamp on this little keyboard. This will be a great scheme for advertising, giving election returns, etc.

THE DWARF TREES OF JAPAN.

ONE of the most interesting parts of the section of Horticulture at the Trocadero is certainly the small inclosure of bamboos in which the Japanese garden is installed. The visitors who enter this are surprised at once by the smallness, the bulkiness, the deformity, and the age of the plants exhibited there in those pots of brilliant porcelain that are now so much admired. In fact, if we examine the label to ascertain the age of one of these plants whose height is scarcely 20 inches, and whose trunk appears to be 2½ or 3 inches at the most in diameter, we shall read with astonishment that it is 80, 100, 110, or even more years of age. On attentively examining the plant, we see that its deformed roots rise above the earth and sustain the trunk above the surface, and that nearly all the branches are tied with small bamboo fiber bands so as to render them sinuous, to make them describe numerous zigzags, and to bring them as near as possible to the trunk without, however, getting them too far from their habitual situation. The plant, as a whole, exhibits a strange aspect; it is twisted, bent out of shape, and, above all, is very much dwarfed. Thus, in the Japanese garden, we find pines of from

16 to 24 inches in height which in nature are 30, 60, 90 or more feet in height; maples in large numbers, varying from 12 to 30 inches, that usually reach 30 or 35 feet; and, finally, oaks reduced to 16 or 20 inches, which in nature are 50 to 60 feet. Moreover, the number of these dwarf trees is relatively large, and there

FIG. 1.—A GROUP OF DWARFED PLANTS, CONSISTING OF SEVEN SPECIES.

are very many varieties. We may, in fact, see in the Japanese garden such conifers as *Pinus densiflora* and *P. Japonica*, *Thuyopsis deolabrata* (Kifu-asunaro), *Podocarpus Nageia* (Fuiri-nagi), *P. Macrophylla* (Kakuhamaki), *Ginkgo biloba*, *Cupressus Corneyana* (Itohiba), etc.; and such other trees as *Quercus cuspidata*, *Q. phillireoides*, *Ternstræmia Japonica*, *Pittosporum Tobira*, etc.

By what processes do the Japanese horticulturists ob-

FIG. 2.—THUYOPSIS DEOLABRATA, 112 YEARS OF AGE.

tain theses dwarf trees? This is a question that has more than once excited the curiosity of naturalists. As long ago as the time of the universal exhibition of 1878, the dwarf trees of the Japanese section, which were less numerous and varied than those of the present exhibition, attracted the attention of French botanists and horticulturists. Mr. Carriere, in an article published in the *Revue Horticole* in 1878, gives various theories as to the means employed for effecting this dwarfing. He rightly attributed a great influence to the distortion and the tying of all the branches. From his experiments, he thinks there is another method of dwarfing, and that is the methodical removal of a certain number of leaves, thus reducing the assimilating surface of the plant and retarding its development. This year, the dwarf trees of Japan have again attracted the attention of botanists, and very recently, at the last session of the Botanical Society of France, Mr. J. Vallot discussed the question. Like Mr. Carriere,

FIG. 3.—THUYA, 80 YEARS OF AGE.

he recognizes the influence of tying, but he suggests, in addition, another process, and that is the pruning of the primary branches and roots, combined, when necessary, with grafting.

We had the good fortune at the exposition to make the acquaintance of Mr. Saichiro Takuda, attache of the botanical section of the Imperial Museum of Tokio, and of Mr. Kasawara, an exhibitor of dwarf trees. Both of them, with an obligingness and a disinterestedness that we are glad to acknowledge here, were good enough to give us some valuable information as to the processes employed by Japanese horticulturists for obtaining dwarf trees.

The plants designed to be dwarfed are raised in small pots until their roots, having absorbed all the earth that they contain, fill them exactly. Then the pots are changed for others that are not much larger than the first, and which the roots soon fill. Then the pots are changed again, and so on. Thus interfered with in its development and deprived of nourishment (for the quantity of earth in the pot is very small, and just enough water is introduced to support life), the tap root soon becomes atrophied and even destroyed, while the rootlets are unable to develop either in suffi-

FIG. 4.—PINUS JAPONICA, MORE THAN 100 YEARS OF AGE.

cient number or quickly enough to replace it. This process appears to be the most important of those that the Japanese horticulturists employ, and, as may be seen, it retards the growth and notably modifies the appearance of the plants submitted to it. It is to it that is due the raising of the trunk out of the earth by roots crowded into too small a pot.

The second process consists in preventing, as far as

FIG. 5.—CEPHALOTAXUS, 90 YEARS OF AGE.

possible, the branches from spreading out freely in the air. To this effect, they are tied at an early stage either to the trunk or to one another, and are bent backward and forward several times in a zigzag form. The tree then exhibits a globular, ovoid, conical, or pyramidal shape, grows with difficulty, and enlarges but slowly. It often happens that a branch dies in consequence of the binding and tying. In this case, it is lopped off, and a lateral branch develops under the section and replaces the other. But, aside from this, the trees

FIG. 6.—NANDINA DOMESTICA, FRUITING BRANCHES GRAFTED ON A 70 YEAR OLD TRUNK.

under treatment are never pruned, nor are the leaves ever removed in order to diminish the evaporation or assimilation. The leaves remain small in the conifers and develop poorly and last but a short time in the dicotyledons.

Whetever be the plants submitted to the experiment, the processes are the same. But the result is far from being the same with all. It will be readily observed in the Japanese garden that the conifers are the ones that are the most easily dwarfed and made to assume the form that the horticulturist desires to give them. The ginkgo is the sole exception, and resembles the dicotyledons. These latter are rebellious to the treatment, in consequence of the facility with which they

FIG. 7.—GINKGO BILOBA, 60 YEARS OF AGE.

produce lateral and adventive shoots to replace the branches arrested in their development by being tied. Still, with truly remarkable stubbornness and patience, the Japanese horticulturists succeed in dwarfing them. They continue to tie the young branches in measure as they develop, lop off the dead branches, and, by grafting, replace them if the plant is worth the trouble, and the vacant space interferes with the general form that they wish to obtain. Finally, they employ here another process; they twine the plant around a support as if it were voluble. These supports are of two kinds—sometimes elongated fragments of the trunk of a tree form, and sometimes fragments of polyps, madrapores, etc., the crooked forms of which agree better with those of the trees.

It often happens that, owing to the treatment they receive, all the branches die. They are in that case all cut off, and young branches are grafted on the large, knotty, misshapen trunk.—*Le Naturaliste.*

THE SUGAR CANE DISEASE.

GREAT loss is resulting in Java from the sugar cane worm, which is thus described by Dr. Soltwedel in an essay which accompanies a report from U. S. Consul Horatio G. Wood:

In the cane itself, we have very seldom found the parasite, and when found it was always in that part of the cane which was underground, and only there, where it has already been destroyed by other parasites, therefore we have never found them high up above ground, or between the leaf storks. The development of the parasite, therefore, takes place in the roots only, and there it has its abode during all its existence, and it is only when abandoning a destroyed root in search of a living one that it is discovered in the ground. Besides the sugar cane we have so far only found the parasite in the roots of the sorghum plant. In the roots of rice and maize we found several varieties of the *Tylenchus*, but whether among these *Tylenchus sacchari* is to be found, we cannot for the present state with any certainty. Both sexes of the *Tylenchus sacchari* are found in almost equal proportion; their sizes cannot be said to vary much from each other. The size of the female is 0·77 millimeter; that of the male, 0·71 millimeter; the esophagus attains with both sexes a length of almost

one-sixth, the tail of both almost one-thirteenth of the length of the body. The vulva in the female is found at a distance of one-fifth of the length of back part. The width of the female is 0·03 millimeter, that of the male 0·026 millimeter. The stylet is, in length, 0·012 millimeter. The porus excretorius extends very high, and is 0·027 millimeter distant from the mouth. The stylet, with three knobs underneath, so characteristic of the species of *Tylenchus*, is very distinctly seen in this parasite. To these knobs it seems that a strong muscle is attached. We very often saw the dart pushed out of the mouth as far as the half of its length. The embryo also uses this dart to pierce the thin cuticle in which it is enveloped. During the period of sloughing, these knobs disappear, and the dart becomes very much attenuated. Whether it entirely disappears, and is again afterward reformed, we cannot as yet say with any certainty. Now and then, but very seldom, have we observed that during the sloughing the dart disappears very deep into the throat. The esophagus, with the two bulbus, is, as well as with other species of *Tylenchus*, very distinctly to be seen in this parasite. The same thing with the intestines, as they are covered with large grains. The aperture of the mouth is found in front, above a little projection, to which little lips are attached. The little rings of the integument of the *Tylenchus* we have not been able to find in this parasite. The side membrane, or web, can only be seen in the male, and is very small. As well as with all other species of *Tylenchus*, the *Tylenchus sacchari* has, as far as regards the side vessels, but one only, which extends through a small porus to the belly. This porus seems to be covered by a cuticle, which is very distinctly visible in the sloughed skin. The ovary is uneven, and sometimes very distinctly visible. It extends as far as the under part of the esophagus. The vulva forms a broad split, with somewhat swollen lips. A uterus is not to be discovered. In the male the penis is not very distinctly marked; we also could not discover any well developed spermatozos. After ejections, they resemble little round productions. The bursa is very small, and is quite free from the point of the tail. The two spiculi are clearly visible, but the accessory nerve we could not, however, discover. The eggs, after having been fecundated, are generally thrown out before their final development, though we saw at times in the body of the female an egg with a well developed embryo. In the egg membrane is often seen a small navel speck, which is, perhaps, formed by the injected spermatozos.

In order to be able to oppose successfully this parasite, it is especially necessary for us to know exactly its habits and domestic economy.

We are at this moment quite convinced of the fact that the parasite is disseminated not only from the cane cuttings which have taken roots, but also from the earth from infected gardens. On the other hand, we do not think that the *Tylenchus sacchari* is brought in the top cutting or seeds of the cane plant, if they are free from infected earth. Further, it seems to us that this parasite, in order to develop, requires a great deal of moisture. Very often we found, after several consecutive dry days, when no rain whatever had fallen, in the roots very many parasites which had died. After long and incessant dry weather the *Tylenchus sacchari* is found sporadically only in high-lying grounds. The fact that the *Tylenchus* loses its vitality in consequence of long-continued dryness or drought, we can explain as follows: Young roots which were quite full with *Tylenchus* we have dried in the air, and a few weeks afterward, after having put moisture on them, we examined them. The results were that the *Tylenchus* were quite motionless, and that, also, after twenty-four hours no signs of life were observable in them.

A PETRIFIED FOREST IN ARIZONA.

We are going to describe to our readers one of the wonders of the United States that is as yet very little known; we refer to a petrified forest in Arizona. On the other side of the Atlantic, it is known as Chalcedony Park. This forest of trees, converted into silex and agates of great beauty, is situated at fifty miles to the southeast of Holbrook, in Apache County. The silicified trees are found in volcanic ground above ashes and lava that form a deposit of from 18 to 30 feet in depth. The deposit of petrified tree trunks extends over large surface of ground, and the total mass exceeds millions of tons. Here and there, piled up in confusion, we meet with silicified trunks that are sometimes ten feet in diameter, and that represent giants of the vegetable world comparable to those of Yosemite or Calaveras. What renders this deposit particularly interesting is that the material that constitutes the petrified trees is not a silex of mean aspect, but an agate of incomparable beauty when polished. It comprises all the colors of the rainbow—yellow and red prevailing, and making it one of the most admirable hard stones that can be imagined. Sometimes crystals of the purest violet amethyst are met with in the mass.

Fig. 1.—TOP OF JASPER HILL, ARIZONA.

The engravings will give an idea of the richness of the park in petrified trees. Fig. 1 gives a view of the top of a hill (Jasper Hill). Fig. 2 shows the entrance to a locality called Chalcedony Canon, and Fig. 3 shows the aspect of one of the principal curiosities of this strange world. It is a natural bridge, which is 28 feet in length, and is formed of an entire tree converted into silex.

It is difficult to say with certainty what the species of trees are that have ceded their substance to deposits of silex, but it is probable that we have to do here with antediluvian forests swallowed up in volcanic phenomena and converted into silicious matter. After having been buried for a long time in volcanic ashes, the tree trunks, under the action of silicious water, have been converted into silex, or, rather, their organic molecules have been gradually replaced by silicious ones. In these phenomena of petrifaction there is not a transmutation of substance, but a simple substitution.

According to the opinion of able American mineralogists, among whom we may name Mr. George F. Kunz, of New York, the silicified forest of Arizona is a wonder of the mineral world, and, according to this specialist, the jasper and agate that it furnishes are the most remarkable substances of the kind that exist on the surface of the globe.

Petrified trees have often been met with, but, up to the present, nowhere have they been met with in such abundance at the same place, and of so interesting material from a mineralogical point of view.

According to the micrographic observations of Mr. P. H. Dudley, of New York, it would appear that the nature of certain petrified trees of this park approaches that of the genus *Araucaria*, and that others have an analogy with a cedar—*Juniperus Virginianus*.

This petrified wood is now exploited by the Drake Company, which is exhibiting its products at our mineral exposition. In the exhibit of this company may be seen polished jaspers and agates that are the admiration of all the visitors; entire trunks of trees of which the cut and polished sections form tables of wonderful beauty; and various objects of art that we recommend to the lovers of Nature's curiosities. The

Fig. 2.—PETRIFIED TREES IN CHALCEDONY CANYON.

Drake Company's representative at Paris has been good enough to send us the interesting photographs that we here reproduce, and to give us the information that we have above published.—*La Nature.*

ON THE OCCURRENCE OF PARAFFIN IN CRUDE PETROLEUM.*

By E. A. Partridge, University of Pennsylvania.

It is well known that paraffin obtained by the distillation of petroleum residues is crystalline, while that obtained directly (as in the filtration of residuum) is amorphous. Ozokerite or ceresine differ but slightly from paraffin, the principal distinction being want of crystalline structure in it as found. Other characteristics, such as the melting point, specific gravity, etc., vary in both, and so are not of importance in a comparison. Hence it has been asked, is the paraffin occurring in petroleum and ozokerite identical with that which is produced by their distillation? As crystalline paraffin could be obtained from ozokerite by distillation alone, many persons have supposed that it was engendered in the process. Recently, however, crystalline paraffin has been obtained from ozokerite by dissolving the latter in warm amyl alcohol; on cooling, the greater part separates out in crystals having the luster of mother-of-pearl. By repetition of this pro-

* An abstract of a thesis read before the Chemical Section of the Franklin Institute.

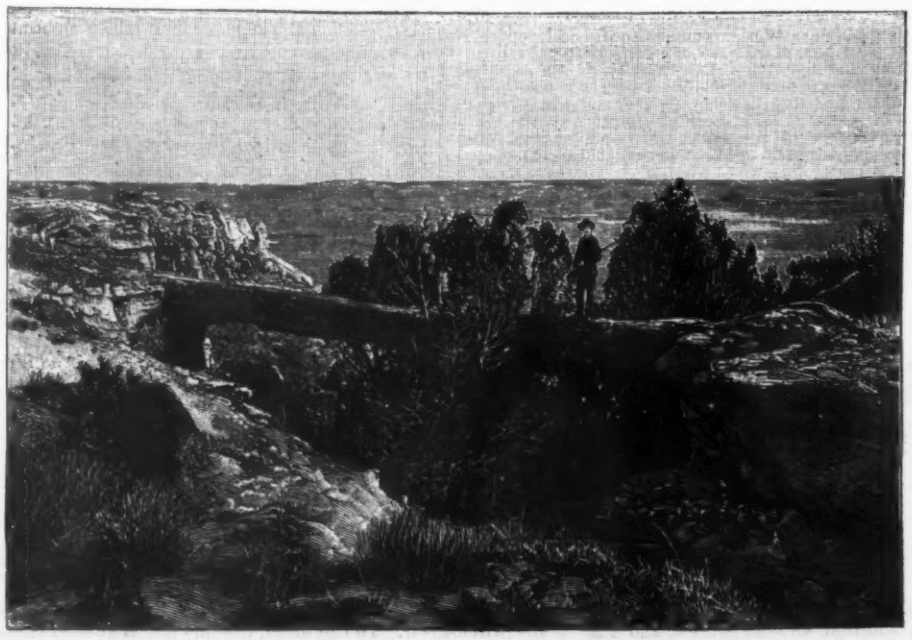


Fig. 3.—BRIDGE FORMED BY A PETRIFIED TREE, CHALCEDONY PARK.

cess, a substance is obtained that is scarcely to be distinguished from the paraffin obtained by distillation. Apparently there exists then in ozokerite, together with paraffin, other substances not capable of crystallization which keep the paraffin from crystallizing. These colloids appear to be separated by amyl alcohol in virtue of their great solubility in that menstruum. It is also reasonable to suppose that they undergo change or decomposition by distillation.

So as petroleum residues are amorphous, and the crystalline paraffin is first produced by distillation, it has been argued that the paraffin present in crude petroleum is approximately the same thing as ozokerite.

This, however, is not sufficient to establish the pyrogenic origin of all crystallized paraffin, as crystals can be obtained from the amorphous residues by distillation at normal or reduced pressure, or in a current of steam. To explain these facts two assumptions are possible. Either the chemical and physical properties of all or some of the solid constituents are changed by the distillation, and the paraffin is changed from the amorphous into the crystalline variety, or the change produced by the distillation takes place in the medium (*i. e.*, the mother liquid) in which the paraffin exists. The change effected in ozokerite and in petroleum residues when crystalline paraffin is obtained by distillation is to be regarded as a purification, and can be effected partly by treatment with amyl alcohol. In the same way, by repeated treatment of the petroleum residuum with amyl alcohol, a substance of melting point 59° C. can be obtained, which cannot be distinguished from ordinary paraffin.

The treatment with amyl alcohol has therefore accomplished the same results as were obtained by distillation, and the action is probably the same, *i. e.*, a partial separation of colloid substance. These facts point to the conclusion that crystallizable paraffin exists ready formed in both petroleum and in ozokerite, but in both cases other colloidal substances prevent its crystallization. By distillation, these colloids appear to be destroyed or changed so as to allow the paraffin to crystallize.

It is a generally known fact that liquids always appear among the products of the distillation of paraffin, no matter in what way the distillation be conducted. This shows that some paraffin is decomposed in the operation.

The name *proto-paraffin* has been given to ozokerite, and to the paraffin of petroleum in contra-distinction to *pyro-paraffin*, the name that has been applied to paraffin obtained by distillation from any source.

According to Reichenbach, paraffin may crystallize in three forms: needles, angular grains, and leaflets having the luster of mother-of-pearl. Hofstadter, in an article on the identity of paraffin from different sources, confirmed this statement, and added, further, that at first needles, then the angular forms, and then the leaflets are formed. Fritsche found, by means of the microscope, in the ethereal solution of ozokerite, very fine and thin crystal leaflets concentrically grouped, and in the alcoholic solution fine irregular leaflets. Zaloziecki has recently developed these microscopic investigations to a much greater extent. According to this observer, the principal part of paraffin, as seen under the microscope, consists of shining stratified leaflets with a darker edge. The most characteristic and well-developed crystals are formed by dissolving paraffin in a mixture of ethyl and amyl alcohols, and chilling. The crystals are rhombic or hexagonal tablets or leaves, and are quite regularly formed. They are unequally developed in different varieties of paraffin. The best developed are those obtained from ceresine. Their relative size and appearance give an indication as to the purity of the paraffin, and as they are always present they are to be counted among the characteristic tests for paraffin. Reichenbach observed that mere traces of empyreumatic oil prevented their formation.

The old method of determining the amount of paraffin in petroleum was to carry out the refining process on a small scale; that is, to distill the residue from the kerosene oils to coking, chill out the paraffin, press it thoroughly between filter paper, and weigh the residue. The sources of error in this procedure are manifold; the principal one is the solubility of paraffin in oils, which depends upon the character of both the paraffin and the oil, and also upon the temperature. The next greatest source of error is variation in the process of distillation, and the difference between working on the small scale and on the large scale.

In most cases, where a paraffin determination is to be carried out, one has to deal with a mixture of paraffin with liquid oils. Now, paraffin is not a substance defined by characteristic physical properties which distinguish it from the liquid portions of petroleum. It consists of a mixture of homologous hydrocarbons, which form a solid under ordinary conditions. The hydrocarbons of this mixture show a gradation in their properties, and gradually approximate to those which are liquid at ordinary temperatures. It is a well-known fact that a separation of these homologues is entirely impossible by distillation. It has also been ascertained that the liquid constituents of petroleum do not always possess boiling points that are lower than those of the solid constituents. This shows that we have to deal not merely with hydrocarbons of one, but of several series.

When determinations of the amount of paraffin are to be made, then it becomes necessary to specify with exactness what is to be called paraffin. The most definite property that can be made use of for this purpose is the melting point. For several reasons it is convenient to include under this name hydrocarbons of melting point as low as 35°–40° C.

The method proposed by Zaloziecki for the determination of paraffin is the following: The most volatile portions of the petroleum are separated by distillation, until the thermometer shows 200° C. These portions are separated, as they exert great solvent action upon paraffin.

At the same time, he finds that no pyro-paraffin is formed under this temperature. A weighed portion of the residue is taken and mixed with ten parts by weight of amyl alcohol and ten parts of 75 per cent. ethyl alcohol; the mixture is then chilled for twelve hours to 0° C. It is then filtered cold, washed first with a mixture of amyl and ethyl alcohols, and then with ethyl alcohol alone. The paraffin is transferred to a small porcelain evaporating dish and dried at 110° C. It is then heated with concentrated sulphuric acid to 150°–160° C. for fifteen to thirty minutes with constant stirring. The acid is then neutralized and the paraffin extracted by petroleum ether. On evaporation of the solvent, the paraffin is dried at 100° C., and weighed. Zaloziecki found according to this method, in three samples of Galician petroleums, 4·6, 5·8, and 3·5 per cent., respectively, of proto-paraffin. The method was carried out as above, with four samples of American petroleums, Colorado oil from Florence, Col.; Warren County oil from Wing Well, Warren, Pa.; Washington oil from Washington County, Pa.; Middle District oil from Butler County, Pa., all furnished by Professor Sadtler.

They were very different in physical properties and in appearance, the Colorado oil being a much heavier oil than the others, and the Washington oil being an amber oil, while the other two were of the ordinary dark green color and consistence. The losses on distillation to 200° C. were very different, being about one-tenth in the case of the Colorado oil, and nearly one-half in the case of the others. The percentages of partially refined proto-paraffin in the four reduced oils (all below 200° C. off) were as follows: For the Colorado oil, 23·9 per cent.; for the Warren oil, 26·5 per cent.; for the Washington oil, 26·6 per cent.; and for the Middle District oil, 28·2 per cent.

The question now arises, what value has this determination of the proto-paraffin which may exist in an oil? As before said, a portion of the paraffin is always decomposed in distillation at temperatures sufficiently high to drive over the paraffin oils, so the yield of pyro-paraffin is always less than the proto-paraffin shown to be present originally. Zaloziecki found this in the case of the several Galician oils he examined. Corresponding to the 4·6, 5·8, and 6·5 per cent. of proto-paraffin in the several oils, he obtained 2·18, 2·65, and 2·35 per cents., respectively, of pyro-paraffin.

For the present, however, the extraction of proto-paraffin on a large scale by means of such solvents as amyl and ethyl alcohols is out of the question on account of their cost. A distillation, under reduced pressure and with superheated steam, would, however, prevent much of the decomposition of the original proto-paraffin and increase the yield of pyro-paraffin.

This study of Zaloziecki's method and the examination of American oils was suggested by Professor Sadtler, and carried out in his laboratory.

HYDROQUINONE AS A DEVELOPING AGENT.

By J. WILSON SWAN, M.A., in the *British Journal of Photography*.

WITH regard to a definite formula for a *quinol* developer, I may say, that Mr. John Green, of Mawson & Swan's plate works, has made innumerable experiments with a view to arrive at a formula that would most generally meet the wants of the photographer in the studio and in the field, that would give a fine quality of image, a good color, and develop in the same time as pyro and ammonia. The result of these experiments is the following formula:

A.

Hydroquinone (quinol)	80 grains.
Citric acid	10 "
Sulphite of soda (recrystallized)	80 "
Distilled water	20 ounces.

B.

Caustic potash (fused)	160 grains.
Sulphite of soda (recrystallized)	160 "
Distilled water	20 ounces.

C.

Bromide of potassium	24 grains.
Distilled water	1 ounce.

D.

Caustic potash (fused)	160 grains.
Distilled water	20 ounces.

Fixing solution: Hyposulphite of soda, 1 lb.; water, 40 ounces.

For normal exposures use equal parts of A and B, adding five minims of C for every ounce of solution.

For over-exposed plates use D instead of B, with an extra quantity of C.

For under-exposed plates omit C, and, in extreme cases, add six or eight grains more of sulphite of soda to every ounce of developer.

Plates showing a tendency to frill should be immersed for one minute in a five per cent. solution of common alum between development and fixing; washing before and afterward.

Note.—The object of decreasing or increasing the quantity of sulphite is to give greater or less density.

SUGGESTIONS.

Make solutions A, B, and D with one-half the quantity of water indicated in this formula (10 oz. instead of 20 oz.)

For a 4 oz. developer take 1 oz. of A, 1 oz. of B, 20 to 30 minims of C, and add 2 oz. of water. This gives the normal developer.

Make solution E.—120 grains sulphite of soda to 1 oz. of water.

If the normal developer produces too great density, substitute E for such portion of the added 2 oz. of water as the case requires.

American plates will seldom require the use of solution D in place of B. G. H. R.

THE oldest pieces of wrought iron now known are probably the sickle blade found by Belzoni under the base of a sphinx in Karnac, near Thebes; the blade found by Colonel Vyse, embedded in the masonry of the great pyramid; the portion of a crosscut saw exhumed at Nimrod by Mr. Layard—all of which are now in the British Museum. A wrought bar of Damascus steel was presented by King Porus to Alexander the Great, and the razor steel of China for many centuries surpassed all European steel in temper and durability of edge. The Hindoos appear to have made wrought iron directly from the ore, without passing it through the furnace, from time immemorial, and elaborately wrought masses are still found in India, which date from the early centuries of the Christian era.

SACCHARIFICATION BY MEANS OF DIASTASE.

A SERIES of experiments are described on the saccharification of starch by means of solutions of gluten. As solvents, hydrochloric acid, acid sulphate of potassium, phosphoric acid, the acid phosphates of the alkalies, acetic, tartaric, lactic, and formic acids were found most satisfactory, the solutions being obtained by treating fresh, well-washed, and pressed gluten with the solvent at about 40° C. for 4 to 5 hours. These solutions do not coagulate on boiling; on addition of caustic potash drop by drop, a precipitate is formed, soluble in excess; mercuric chloride has no action, and potassium ferrocyanide produces a precipitate soluble in acetic acid.

With an alkaline solution of a copper salt a slight reduction takes place, probably due to the presence of a little saccharified starch; the solutions also give Lintner's reaction for diastase, viz., the blue coloration with hydrogen peroxide and tincture of guaiacum, but previous boiling or the addition of a concentrated solution of a base or of an acid prevents the formation of the color. The resemblance of these solutions of gluten to diastase is borne out by their action on starch, which in the form of starch paste is converted by them at a temperature of 50°–60° into soluble products with a powerful reducing action. To effect the change the solution must be very dilute and very slightly acid; previous boiling prevents the action. In one experiment 2 grms. of starch (= 1·76 grms. of pure starch) dissolved in 250 grms. of water were treated with 10 c. c. of a solution, containing the gluten from 20 grms. of wheat flour dissolved in 130 c. c. of a 1:1,000 solution of acid sodium phosphate, for 5 hours at 40°–50° C.; a liquid wort resulted capable of reducing 138 c. c. of Soxhlet's solution of a copper salt in caustic potash; the complete saccharification of this quantity of starch by diastase would correspond to a reduction of 200 c. c. of the solution.

Albumen and gelatin under similar conditions only effect a slight saccharification of starch, while neither acid phosphate of soda, acetic acid, nor hydrochloric acid in the dilute state employed for dissolving the gluten have any solvent action on the starch. The vegetable albumen contained in wheat flour also acts like diastase. Solutions prepared by digesting wheat flour with acid phosphate of potassium are capable of converting starch into saccharine matter; this saccharification is aided by slightly acidifying the solution. Non-germinated barley also contains a constituent capable of saccharifying starch, and at a temperature of 50°–66° C. converts about two-thirds of the starch into soluble products. Here again the presence of small quantities of acid or of acid salts increases the action. The saccharification is best started at a temperature of 40°–45° C., and continued at 60°–66° C. A number of experiments with barley, malt, and maize, as well as with mixtures of these, and employing solutions of acid sulphate of potassium, acid phosphate of potassium, acetic acid, and metaphosphoric acid, are detailed. The saccharification of the starch of barley, maize, and wheat by the soluble ferments prepared as above forms the subject of a further series of experiments. The action is greatest in the case of barley, 50 to 86 per cent. of the contained starch being saccharified; the conversion is aided by the presence of potato starch.—*A. Reychler, Bull. Soc. Chim.*

IMPROVEMENTS IN THE MANUFACTURE OF STARCH, DEXTRIN, AND GRAPE SUGAR.

STARCH sugar of commerce mostly consists of a mixture of 64–66 per cent. of fermentable sugar, 18–20 per cent. of unfermentable organic matter, and 14–18 per cent. of water, and is considered almost useless for the preparation of wine and liquors and for brewing purposes; moreover, its employment for the manufacture of these products is illegal in Germany, Austria-Hungary, and in France. Although many attempts to obtain a purer product have been made during the last few years, the methods hitherto proposed have been found to be of no practical utility.

Seyberlich and Trampedach have recently worked out a process for preparing pure grape sugar on a commercial scale, which has been patented in most countries. The original experiments were made at the starch sugar works owned by P. Brandenburg in Riga, 1,000 kilos. of air-dried starch being operated upon at a time. The process is, in its essential points, directed toward the method devised by Soxhlet (this journal, 1882, 376). The patentees consider the purification of starch sugar by means of methyl alcohol as practiced by Soxhlet impracticable, on the ground of the high price of alcohol and its great volatility; moreover, the expenses incurred in evaporating vast quantities of liquors and the necessity of employing excessive quantities of charcoal, coupled with certain difficulties attending the subsequent crystallization of the sugar, present great obstacles to the successful working of the process. The large consumption of charcoal is brought about by the fact that the saccharification is effected by means of sulphuric acid under pressure, the high temperature to which the mixture is exposed frequently giving rise to the formation of dark-colored products which require the use of excessive quantities of charcoal for the purpose of decolorization. Seyberlich therefore made some trials to determine the effect of other acids. Hydrochloric acid being unsuitable, nitric acid was tried, the result being satisfactory in every respect. The saccharification was conducted in open vessels, one part of starch being mixed with two parts of water, and the mixture treated with 0·5 per cent. of nitric acid on the weight of air-dried starch.

For the preparation of the raw sugar the authors propose to make the starchy material into a milk with water, boil with nitric acid, neutralize the solution, then render it slightly alkaline, filter, evaporate to 35° B., cool to 18° C., and allow to crystallize in copper pans. The resulting sugar is then subjected to hydraulic pressure, the pressed cakes of raw sugar thus obtained containing 88 per cent. of real sugar, 10 per cent. of water, and 2 per cent. of impurities. The sirup is concentrated for crystallization, and the final liquors (molasses) worked up for sugar after removal of the nitric acid and salts by means of sulphurous acid. The raw sugar is refined by dissolving it in water, bringing the solution to a density of 32° B. (measured hot), decolorizing with charcoal (10 per cent. on the weight of raw sugar) at 80°–90°, and filter-pressing.

The colorless sugar solution is then allowed to crystallize, and the product freed from the mother liquors by pressing. The solution is concentrated for the purpose of separating a further batch of crystals, while the final syrup is mixed with a fresh portion of raw sugar to be refined. By melting the sugar cake and heating to boiling, then adding some crystals of anhydrous grape sugar and allowing the mixture to cool, anhydrous grape sugar is obtained. When this is broken up and sifted, a crystallized product resembling cane sugar is obtained. It contains 98 per cent. of sugar and 2 per cent. of water.—*Dingl. Polyt. J.*

ABSORPTION OF HYDROGEN BY METALS.

THE author's chief results are as follows: 1. The increase of palladium in bulk, when charged electrolytically with hydrogen, takes place equally in all directions. 2. The contractions on discharge by the development of oxygen become smaller with the number of charges, but show no regularity. 3. Palladium can absorb permanently only a certain quantity of hydrogen. Any proportion of hydrogen taken up in excess is spontaneously liberated. 4. Below this limit of saturation the expansion of palladium and of the alloy of palladium and platinum are proportional to the quantities taken up. 5. The absorption of hydrogen by palladium and by the alloy above the limit of saturation is attended with expansion, and its spontaneous elimination with contraction. 6. In palladium the expansion by supersaturation is equal to the contraction on the spontaneous escape of hydrogen. 7. To each strength of current there corresponds a certain degree of supersaturation which cannot be raised by protracted electrolysis. 8. Probably with the supersaturation, reached at any given strength of current, there occurs a stationary condition, in which as much hydrogen penetrates into the cathode per second as there is set free in the same time. 9. After the limit of saturation has been exceeded, the volume of palladium increases more rapidly for an equal absorption of hydrogen than corresponds to a similar absorption below the limit. Hence in supersaturated palladium the hydrogen exists in a far lower density than it does in palladium below the limit of saturation. 10. Hydrogen diffuses itself in palladium wire in the course of half an hour to a distance of 4–5 mm. from the point of the wire exposed to electrolysis. 11. In the supersaturated state both palladium and its platinum alloy show a far greater hydrogen polarization than in the saturated state. 12. Iron, as well as palladium, can be supersaturated with hydrogen, so that the gas is spontaneously eliminated. 13. This supersaturation occurs when iron comes in contact with dissociated hydrogen in the voltmeter or on the action of acid upon the iron, but not when the iron is exposed to free hydrogen. 14. In iron a certain degree of supersaturation corresponds to every strength of the current. 15. The quantities of hydrogen spontaneously evolved from supersaturated iron are proportional to the surfaces of the charged iron.—*Dr. Max Thoma.*

CRYSTALLINE TANGHININE FROM THE TANGHINIA VENENIFERA OF MADAGASCAR.

By M. ARNAUD.

THIS poisonous principle is concentrated in the kernel of the fruit of an apocyeous tree. The oily matter, which forms about 75 per cent. of the kernel, is perfectly harmless. Tanghinine is a heart poison, approximating to strophantine and ouabaine, but, unlike these two, it has a general convulsive action. From 2·550 kilos. of the kernels the author obtains 25 grms. of pure crystalline tanghinine. It is colorless, and crystallizes in rhombs from its alcoholic solution. It is anhydrous, and gives no colored reactions. It melts at 182° to a transparent liquid, and if heated more strongly it burns without any residue. It is very sparingly soluble in water, moderately soluble in ether, and freely soluble in strong alcohol. It deflects the plane of polarized light to the left. If heated with dilute acids it is decomposed, yielding a yellowish resinous product. No reductive sugars are formed, such as are obtained from ouabaine, strophantine, and the other glucosides. It contains rather more carbon than ouabaine and strophantine, but, like the two latter, no nitrogen. It is therefore neither an alkaloid nor a glucoside.

THE TERRESTRIAL ORIGIN OF THE OXYGEN RAYS IN THE SOLAR SPECTRUM.

By J. JANSSEN.

M. EIFFEL having placed the tower in the Champ de Mars at the author's disposal for the experiments and observations which he wished to institute there, he has utilized the powerful source of light installed there for certain studies of the terrestrial spectrum, with especial reference to the origin of the oxygen rays in the solar spectrum.

It is now known that there exist in the solar spectrum several groups of rays due to the oxygen contained in our atmosphere. But it may be asked if these groups are due exclusively to the action of our atmosphere, and if the sun's atmosphere takes no part in them at all, or if their origin is twofold; in a word, are they purely terrestrial or terrestrial-solar?

To decide this question several methods are possible. One of the most certain is that of vibrations, the origin of which may be traced to the fine conception of M. Fizeau, and which has been applied by M. Thollon, and improved by M. Cornu. In the present case, however, its application would seem to be very difficult.

We may also observe the decrease of intensity which the groups undergo as we rise in the atmosphere. By the most careful comparisons and by extended observations, we may judge if the decrease in the intensity of the rays warrants us in inferring their complete disappearance at the boundaries of the atmosphere. This is the method employed in the last expedition to the ridge of Mont Blanc (Grands Mulets). Or we may proceed by a comparison of equality; arranging a powerful light, with a continuous spectrum, at a distance from the instrument, such that the atmospheric stratum traversed may represent the action of the earth's atmosphere upon the sun's rays about the zenith.

These conditions are very happily realized by the respective positions of the Eiffel tower and the observatory of Meudon. The intervening distance is about 7,700 meters, which represents approximately the thickness of an atmosphere having the same weight as the terrestrial atmosphere and a density which is uniform and equal to that of the atmospheric stratum near the sun. Besides, the considerable power of the luminous apparatus installed at the summit of the tower permitted the use of the instrument which the author had employed at Meudon and on the Grands Mulets for the sun. He has also used a collecting lens before the slit, so as to give the spectrum an intensity comparable to that of the solar spectrum in the same instrument With these arrangements the spectrum appeared extremely bright. The field extended beyond A. The group B appeared as intense as with the summer sun at noon. The group A was also strongly manifest. Other groups were also distinguished, especially that of watery vapor; their intensity seemed to agree with the hygrometric condition of the atmospheric stratum traversed.

The author wished to study the oxygen groups with the great spectrometer of MM. Brunner and with M. Rowland's grating, but the limited time during which the light was supplied did not permit.

No oxygen band appeared in the visible spectrum. Still, the thickness of the stratum of oxygen traversed was equivalent to a column of more than 260 meters of oxygen, at a pressure of six atmospheres. This shows that for oxygen the rays follow quite a different law from the bands. While for the rays the recent experiment shows that it seems indifferent whether we use a column of gas of constant density or a column equivalent in weight but of variable density; for the bands, on the contrary, the absorption taking place according to the square of the density, there would be required on the surface of the sun an atmospheric thickness of more than 50 kilometers for their production.

Mr. Janssen considers his experiment as merely supplying an additional fact which requires to be fixed with precision and developed. The height at which the tower of the Champ de Mars enables the luminous focus to be placed, and the power of this focus, promises us further experiments of high interest.—*Comptes Rendus*, vol. cviii., p. 1035.—*Chem. News.*

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